Defense Management Journal

November 1978

Defense Management Journal

Vol. 14, No. 6 **November 1978**

Scope: The *Defense Management Journal* is an official bimonthly publication of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). The *DMJ* highlights DoD policies, programs, progress and problems related to the management of manpower; reserve affairs; logistics; personnel; procurement; transportation; administration; research, development, test and evaluation; and other factors impacting on the total defense effort. The *DMJ* is a medium for the interchange of ideas and techniques for management improvement through the publication of solicited and selected unsolicited articles.

Subscription/Requisition Procedures: Department of Army personnel may requisition the magazine by completing a DA Form 12-4 and forwarding it through their normal publications requisitioning channels. Navy and Marine Corps personnel should submit their requests to Headquarters, Naval Material Command, Code 0424, Crystal Plaza 5, Washington, DC 20360. Air Force personnel should submit an AF Form 764 to their individual supporting publications distribution office. Employees of other governmental agencies should contact their administrative office for consolidation of the agency requirement; the agency should then notify the *DMJ* office.

Individuals employed by the government, as well as organizations and individuals outside the Federal government, may personally subscribe to the *DMJ* through the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. The annual subscription rate is $8.00 ($10.00 for foreign mailing); single copies cost $1.40.

Inquiries: All inquiries, correspondence, articles, and outlines of proposed articles should be directed to: Editor, Defense Management Journal, OASD (MRA&L), Cameron Station, Alexandria, VA 22314; phone: Autovon 284-7558/9, Commercial (202) 274-7558/9.

Manuscripts: Manuscripts submitted for publication should be typed double spaced on one side of 8x10½- or 8½x11-inch paper, leaving at least a one-inch circumferential margin. The preferred length of articles is approximately 3,000 words, or 12 double-spaced pages; lengthier pieces are reviewed on a time-available basis. References and footnotes should be typed on a separate sheet and be numbered consecutively in the order of their appearance in the text. Complete data as to source must be provided.

Continuous-tone and halftone photographs and line drawings can often significantly enhance the readers' understanding of the article. Photos (glossy black and white prints are preferred) and line drawings should be approximately 8x10 inches in size. Complete figure captions should be listed on a separate sheet or be taped to the back of each illustration. Staples and paper clips should not be used for this purpose.

One original and three copies of the manuscript with three sets of all illustrations should be forwarded, using protective cardboard for mailing. Authors submitting manuscripts should include their name, title, address, work affiliation and telephone number, a brief biographical sketch of their background in the field, and a 100-word abstract of the article.

Unless otherwise stated, all submitted manuscripts are received under the assumption that they are original, have not been previously published, and are not being considered for publication elsewhere. Materials accepted for publication become the property of the *DMJ* and will be returned only by special arrangements.

Clearance: Articles submitted for publication must be cleared for public release by the author's local information office. This is preferably accomplished before submission of the manuscript to the *DMJ*'s editors. While an uncleared manuscript can be sent to the magazine, only a preliminary reading and judgment concerning its usability will be effected prior to receipt of local clearance. The *DMJ* staff also clears all articles through the Directorate for Freedom of Information and Security Review, Office of the Assistant Secretary of Defense (Public Affairs), prior to publication.

Defense Management Journal Readership Survey

We want the Defense Management Journal to serve you better. Express your opinions on this pre-addressed, postage-paid questionnaire and return it no later than 15 February 1979.

1. I am employed by:
   Army☐ Navy☐ Air Force☐ DoD☐ Defense Agency☐ Other Federal Agency☐
   Industry☐ Educational Institution☐ Other (specify) _____

2. My grade/rank is (be specific):
   GS-☐ O-☐ E-☐ Other _____

3. I received this issue on: Month _____ Day _____

4. My career specialty is (choose one):
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

5. The subject areas I would like to see covered in the *DMJ* are:
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

6. I find *DMJ* articles:
   Overly difficult to understand☐ Overly simple☐ About right☐ (Optional comments) _____

7. I read the *DMJ* departments in the following manner:

	Read in detail	Skim	Don't read
In Brief (abstracts)	☐	☐	☐
News Summary	☐	☐	☐
Feedback	☐	☐	☐
Calendar	☐	☐	☐

8. I read the *DMJ* to learn about:
   My career specialty☐ Other career specialties☐ Official policy☐
   Other (specify) _____

9. I view articles in the *DMJ* as reflective of:
   Official DoD policy☐ Author's opinion (non-DoD policy)☐ Both ☐

10. I would like: More policy articles☐ More opinion articles ☐ A balanced mix ☐

11. My overall evaluation and comments on the *DMJ* are:

_____

_____

_____

Editor's note: If you are interested in publishing in the DMJ, *in discussing a specific topic you would like to see covered, or in being part of a control group to analyze the* DMJ's *contents in the coming year, please provide the following information:*

I have an article idea to discuss☐. I would like to be part of the control group☐.

Name _____ Position _____

Phone _____ Autovon _____

Defense Management Journal Readership Survey

We want the Defense Management Journal to serve you better. Express your opinions on this pre-addressed, postage-paid questionnaire and return it no later than 15 February 1979.

1. I am employed by:
   Army☐ Navy☐ Air Force☐ DoD☐ Defense Agency☐ Other Federal Agency☐
   Industry☐ Educational Institution☐ Other (specify) _____

2. My grade/rank is (be specific):
   GS-☐ O-☐ E-☐ Other _____

3. I received this issue on: Month _____ Day _____

4. My career specialty is (choose one):
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

5. The subject areas I would like to see covered in the *DMJ* are:
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

6. I find *DMJ* articles:
   Overly difficult to understand☐ Overly simple☐ About right☐ (Optional comments) _____

7. I read the *DMJ* departments in the following manner:

	Read in detail	Skim	Don't read
In Brief (abstracts)	☐	☐	☐
News Summary	☐	☐	☐
Feedback	☐	☐	☐
Calendar	☐	☐	☐

8. I read the *DMJ* to learn about:
   My career specialty☐ Other career specialties☐ Official policy☐
   Other (specify) _____

9. I view articles in the *DMJ* as reflective of:
   Official DoD policy☐ Author's opinion (non-DoD policy)☐ Both ☐

10. I would like: More policy articles☐ More opinion articles ☐ A balanced mix ☐

11. My overall evaluation and comments on the *DMJ* are:

_____

_____

_____

Editor's note: If you are interested in publishing in the DMJ, *in discussing a specific topic you would like to see covered, or in being part of a control group to analyze the* DMJ's *contents in the coming year, please provide the following information:*

I have an article idea to discuss☐. I would like to be part of the control group☐.

Name _____ Position _____

Phone _____ Autovon _____

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DEPARTMENT OF DEFENSE
DoD-302

Editor
Defense Management Journal
OASD (MRA&L)
Cameron Station
Alexandria, VA 22314

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DEPARTMENT OF DEFENSE
DoD-302

Editor
Defense Management Journal
OASD (MRA&L)
Cameron Station
Alexandria, VA 22314

Defense Management Journal Readership Survey

We want the Defense Management Journal to serve you better. Express your opinions on this pre-addressed, postage-paid questionnaire and return it no later than 15 February 1979.

1. I am employed by:
   Army☐ Navy☐ Air Force☐ DoD☐ Defense Agency☐ Other Federal Agency☐
   Industry☐ Educational Institution☐ Other (specify) _____

2. My grade/rank is (be specific):
   GS-☐ O-☐ E-☐ Other _____

3. I received this issue on: Month _____ Day _____

4. My career specialty is (choose one):
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

5. The subject areas I would like to see covered in the *DMJ* are:
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

6. I find *DMJ* articles:
   Overly difficult to understand☐ Overly simple☐ About right☐ (Optional comments) _____

7. I read the *DMJ* departments in the following manner:

	Read in detail	Skim	Don't read
In Brief (abstracts)	☐	☐	☐
News Summary	☐	☐	☐
Feedback	☐	☐	☐
Calendar	☐	☐	☐

8. I read the *DMJ* to learn about:
   My career specialty☐ Other career specialties☐ Official policy☐
   Other (specify) _____

9. I view articles in the *DMJ* as reflective of:
   Official DoD policy☐ Author's opinion (non-DoD policy)☐ Both ☐

10. I would like: More policy articles☐ More opinion articles ☐ A balanced mix ☐

11. My overall evaluation and comments on the *DMJ* are:

_____

_____

_____

Editor's note: If you are interested in publishing in the DMJ, *in discussing a specific topic you would like to see covered, or in being part of a control group to analyze the* DMJ's *contents in the coming year, please provide the following information:*

I have an article idea to discuss☐. I would like to be part of the control group☐.

Name _____ Position _____

Phone _____ Autovon _____

Defense Management Journal Readership Survey

We want the Defense Management Journal to serve you better. Express your opinions on this pre-addressed, postage-paid questionnaire and return it no later than 15 February 1979.

1. I am employed by:
   Army☐ Navy☐ Air Force☐ DoD☐ Defense Agency☐ Other Federal Agency☐
   Industry☐ Educational Institution☐ Other (specify) _____

2. My grade/rank is (be specific):
   GS-☐ O-☐ E-☐ Other _____

3. I received this issue on: Month _____ Day _____

4. My career specialty is (choose one):
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

5. The subject areas I would like to see covered in the *DMJ* are:
   Manpower and Reserve Affairs☐ Administration☐ Finance and Accounting☐
   Personnel☐ Acquisition☐ Research and Engineering☐ General Logistics☐
   Maintenance and Supply☐ Other (specify) _____

6. I find *DMJ* articles:
   Overly difficult to understand☐ Overly simple☐ About right☐ (Optional comments) _____

7. I read the *DMJ* departments in the following manner:

	Read in detail	Skim	Don't read
In Brief (abstracts)	☐	☐	☐
News Summary	☐	☐	☐
Feedback	☐	☐	☐
Calendar	☐	☐	☐

8. I read the *DMJ* to learn about:
   My career specialty☐ Other career specialties☐ Official policy☐
   Other (specify) _____

9. I view articles in the *DMJ* as reflective of:
   Official DoD policy☐ Author's opinion (non-DoD policy)☐ Both ☐

10. I would like: More policy articles☐ More opinion articles ☐ A balanced mix ☐

11. My overall evaluation and comments on the *DMJ* are:

_____

_____

_____

Editor's note: If you are interested in publishing in the DMJ, *in discussing a specific topic you would like to see covered, or in being part of a control group to analyze the* DMJ's *contents in the coming year, please provide the following information:*

I have an article idea to discuss☐. I would like to be part of the control group☐.

Name _____ Position _____

Phone _____ Autovon _____

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DEPARTMENT OF DEFENSE
DoD-302

Editor
Defense Management Journal
OASD (MRA&L)
Cameron Station
Alexandria, VA 22314

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DEPARTMENT OF DEFENSE
DoD-302

Editor
Defense Management Journal
OASD (MRA&L)
Cameron Station
Alexandria, VA 22314

in brief

DMJ

4

Communications, Command, and Control: Changing the Face of Force Management

Robert J. Hermann

In recent years, technological advances in force management and control have revolutionalized traditional command-and-control concepts. While weapons have increased in range and capability, advances in automatic data processing, communications, and other fields of electronics have extended the battlefield to global proportions. Management and integration of forces now require greater technical skill as well as new organizations and procedures. The author, the Assistant Secretary of Defense for Communications, Command and Control (C^3) discusses the unique problems of force control management within DoD and organizational efforts to solve them, the difficulties faced by industry, and current NATO initiatives to increase international cooperation.

12

The Role of Discounting in Problems of Choice

James S. Blandin
and
Peter C. Fredericksen

Discounting, the practice of converting annual cash flows into comparable dollar amounts by diminishing the value of future dollars relative to the prevailing value of the dollar, often breaches prescribed fiscal guidelines. Nonetheless, discounting seems to have its place, particularly where managers must provide specific levels of efficiency and are not fiscally constrained. But is discounting appropriate where managers, operating within fiscal constraints, are tasked with maximizing effectiveness? There are differing schools of thought on this issue. This article takes a look at those divergent precepts and examines the appropriateness of discounting as a management tool in a fixed-budget environment.

16

The Air Force's Experience With Matrix Management

Major Karl T. Thurber, USAF

Under matrix management, an employee may work for two managers—one who heads the functional "shop" for his specialty and another who may employ him on a particular project. Although this unusual approach may seem antithetical to the traditional military chain-of-command concept, it has proven quite effective for the special program offices of the Aeronautical Systems Division at Wright-Patterson Air Force Base, Ohio. In this article, the author illustrates how matrix management works, assesses some of its drawbacks, and suggests that, in many instances, the concept is better suited to meeting management's needs than more orthodox structures.

22

Time Out From Tension

Ruanne K. Peters
and
Herbert Benson

"What you need to do is relax!" well-meaning friends may say, and we sense that they're probably right. But chances are we merely become more nervous worrying that we've received some sensible advice we don't know how to use. In this article, a physician and a health educator present a way for us to learn to follow this advice. They draw their method from techniques that are ages old. In fact, they tell us, the method elicits one of our innate abilities. They call it "the relaxation response." The authors make a convincing case for putting it to use right where it is most needed today—at work.

DMJ's R_x for Reading Vitality

Just as the human body needs regular nourishment to remain healthy and strong, a journal needs the periodic infusion of its readers' ideas and opinions to retain its vitality. Certainly, the "letters to the editor" section of a magazine serves this purpose on a continuing basis. But this issue of the *Defense Management Journal* offers you, the defense manager, that opportunity in the more structured and immediate form of a readership survey.

Over the past two years, the *DMJ* has changed dramatically. This is due in part to the responses to the last readership survey. You asked for a more frequently published magazine, and you got it. You asked the *DMJ* to cover as broad a spectrum of defense management issues as possible in each issue, and you got that, too. Now you are being asked: Is the *DMJ* adequately filling your professional reading needs? What more can the magazine do for you?

The editors at the *DMJ* have made a determined effort to avoid any self-aggrandizement in this questionnaire. While we feel it would be nice to know if the readership finds the *DMJ* to be a visually appealing publication, we believe it is more important to learn why you read certain articles or departments and how you choose what you will read.

The *Defense Management Journal* draws much of its strength from the fact that half of its feature articles are the result of your unsolicited manuscripts. I know of no other magazine that devotes as much space to its readers' submissions. And although this requires the *DMJ* editors to provide authors a wider range of editorial services, we agree that this is as it should be. The *DMJ* is as much the defense manager's publication as it is the Defense Department's official policy magazine.

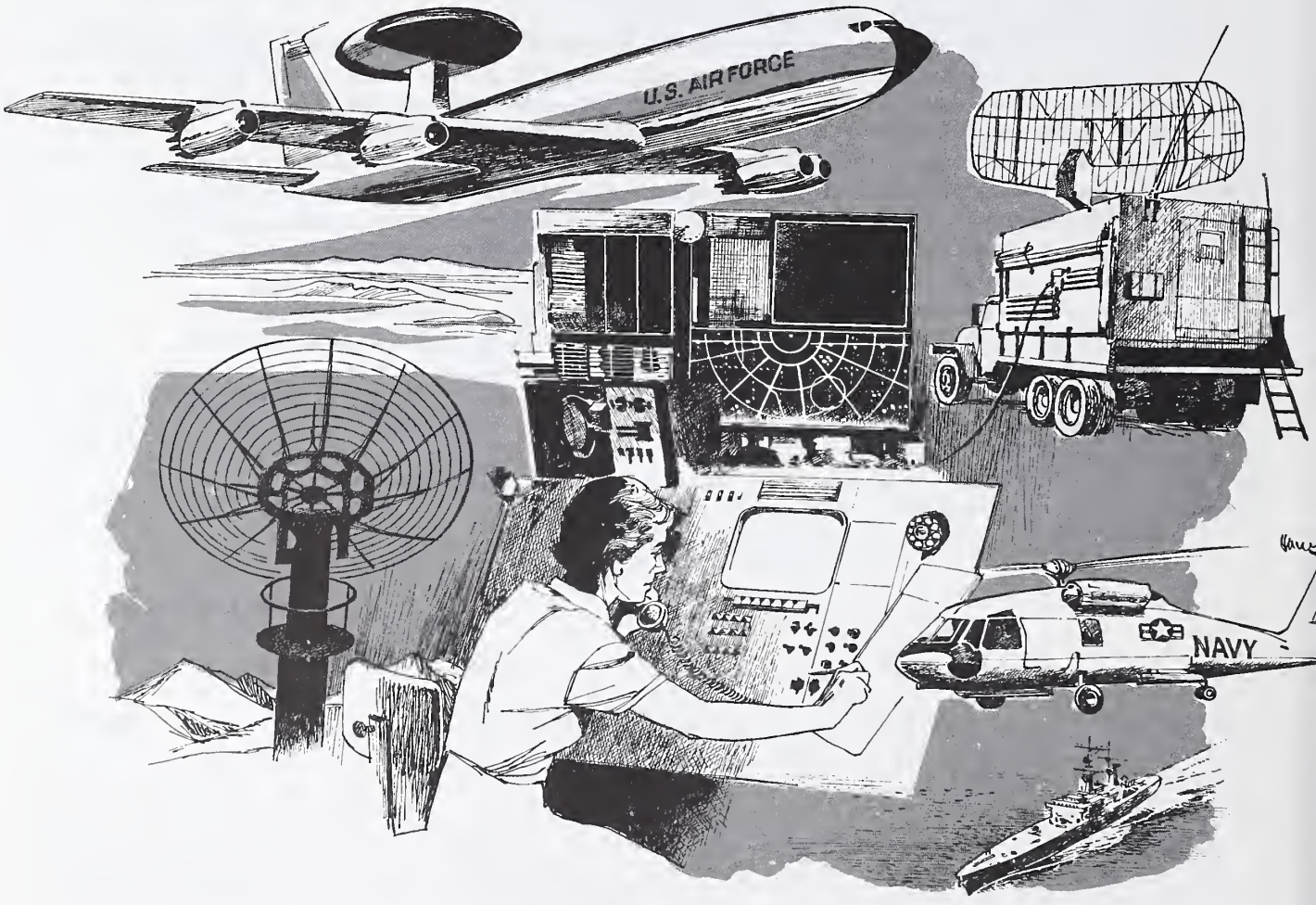
Of course, there is always the danger that the editors do not have their collective finger on the pulse of the needs of the audience. That is why we are asking for your assistance once again. Take the five minutes to fill out the survey card; be constructively critical if you like; add narrative comments when you deem them necessary. Encourage your fellow managers to do the same.

Finally, if you are interested in discussing an article idea, or if you would like to be part of a control group to assess the effectiveness of each issue in the coming year, complete the bottom portion of the survey card and you will be contacted in the near future.

Larry J. Wilson
Editor

Communications, Command, and Control: Changing the Face of Force Management

Increasingly sophisticated technology is challenging traditional force-control concepts and imposing new demands on defense managers.



By Robert J. Hermann

The ability to control weapons and maneuver units rapidly and efficiently is critical to a modern military force. It is particularly crucial to the United States and its allies, which now count on equipment superiority and effective force management to counter a quantitative disadvantage.

Currently, C^3 is the most common U.S. term for force management and control. Literally, it means communications, command, and control, and includes data-processing systems that reduce and manipulate information; navigation systems that provide relative and absolute positions; a considerable variety of sensor systems for intelligence, reconnaissance, and surveillance. These systems are centrally within the purview of the Office of the Assistant Secretary of Defense for Communications, Command, Control, and Intelligence.

Significance

Although C^3 has always been an important aspect of military operations, only recently has it included such an extensive amount of sophisticated technology. C^3 now needs greater management attention and emphasis to keep pace with the state of the art of both those weapons and forces to be controlled and those to be opposed.

Recent technological advances have had a significant impact on the development and application of defense-related systems. These systems include:

- Rocket-powered missiles.
- Computers.
- Sensors.
- Communications, surveillance, and navigation satellites.

Certainly, today's weapon systems have a markedly greater range, speed, and accuracy than previous-generation weapon systems. Concurrently, intelligence, reconnaissance, and surveillance developments have provided for extended geographic coverage, greater precision, and a data-handling capacity to process large volumes of information. Finally, communications systems are providing wider bandwidths over global distances.

There are several important consequences of these new capabilities with respect to force management. These are summarized in Figure 1.

Obviously, the battlefield now poses a problem of integration: the capabilities of multiple units of different services and of different nations must be managed as an integrated whole. This requirement challenges traditional organizational concepts and procedures, particularly those related to command and control.

Furthermore, these technological developments demand greater skill on the part of those who must manage or control weapons and forces. Military systems designers, planners, and most particularly, commanders must increase their technical skills to understand how to use the new force-control machinery in determining the nature of a conflict and utilizing weapons effectively.

Unique Aspects

C^3 has certain characteristics which must be considered in developing and applying new capabilities. For example, C^3 systems are primarily evolutionary in nature. Instead of totally new command-and-control systems being developed, the old systems are continually modified. Naturally, this impacts not only on hardware and software, but on the procedural aspects of management and control as well.

Figure 1. How Recent Technological Advances Have Affected Force Management

The size of a conflict area has clearly expanded beyond line-of-sight and over-the-horizon

Weapons have greater range and capability

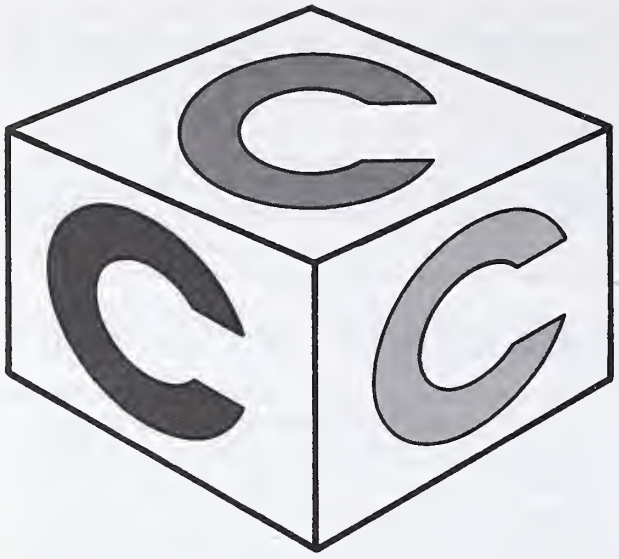
Sensor coverage and capabilities overlap and require coordination for effective use

The coherence of forces depends almost entirely on communications, data processing, and other electronics-related functions

Because C^3 is evolutionary, it needs a central point to control and monitor its evolution. And because the C^3 function permeates the entire command structure, responsibility for its management logically rests with the highest commanding element.

Problems and Solutions

Each of the services acquires, equips, and trains its basic units. But to achieve a combined or allied force,



these basic units must be grouped under a single command. Unfortunately, there are no powerful institutions through which a joint or allied commander can acquire the systems to effectively manage the units under his command. Theoretically, a commander acquires a C^3 capability by expressing a military operational requirement, usually a need for tangible assets. However, such a requirement is rarely satisfied by the mere delivery of a new piece of equipment. Therefore, while the statement of a military operational requirement is necessary, it is not, within itself, sufficient to acquire C^3 capability. Improving a command's C^3 capability requires the careful integration of equipment development and acquisition with a command's mission and organizational structure. This makes it imperative that the user become actively involved in the development process.

Accordingly, the role of the joint-service commands must be expanded in the command-and-control systems management process. These commands must improve their capability for systems planning, configuration management, and implementation of modest system changes. This will require a change in the skills available to the command to enhance both knowledge of the technical control systems and the related procedural aspects of force management.

To support these command activities, it will be necessary to strengthen C^3 support activities. Figure 2 lists several ways that this can be accomplished.

In addition to the services, there are now several organizations which have been created to manage a part of the C^3 process. These include the Defense Communications Agency, which manages the Defense Department's common-user, long-line communications; the Military Satellite Organization, which conducts planning and systems engineering for DoD's communications satellites; the Minimum Essential Emergency Communications and Systems Engineer, who carries out planning and systems engineering to assure the retention of a minimum level of communications with the strategic forces under the most adverse conditions; and the Command and Control Technical Center, which provides technical support for the Worldwide Military Command and Control Systems' automatic data processing and for the National Military Command Center.

There are also three other organizations, two recently created, which assist in the command-and-control interoperability process: the Triservice Tactical Communications Systems Organization (TRI-TAC), the WWMCCS Systems Engineering Organization (WSEO), and the Joint Interoperability of Tactical Command and Control System (JINTACCS) organization. Each has some, but not all, of the attributes necessary to pull together a coherent C^3 program.

Acting for the separate services, TRI-TAC is basically an acquisition agent for tactical switched communications. It accepts service requirements, provides an overall architecture and systems-engineering design, attempts to ensure standardization of systems and procedures, and considers the advisability of introducing new systems instead of modifying existing ones.

Figure 2. Several Ways to Strengthen C^3 Support Activities

Provide C^3 specialists to the joint-service and allied commands to augment the technical expertise available and thereby improve the planning of C^3 systems and processes

Develop technical standards and procedures

Manage the configuration of system characteristics requiring centralized control

Develop C^3 analytical techniques and a permanent cadre of C^3 analysts

WSEO provides architectural and systems-engineering design for the Worldwide Military Command and Control System. Because WSEO was formed in 1976, it is still premature to judge how successful its approach will be; however, improved organizational mechanisms for

linking WSEO to the joint-service and service commands are clearly needed.

JINTACCS designs interfaces for tactical command-and-control systems. Given a list of specific tactical systems which must interoperate, JINTACCS identifies what is necessary to transfer information among them and specifies technical standards needed for support. It monitors the execution of separate projects by the services, which act as its procuring agents.

The collegial approach which characterizes most of these organizations is a useful improvement over past practices. However, these organizations have insufficient design authority and funding control to be a true C^3 architectural force.

C^3 Management in NATO

The need to strengthen the North Atlantic Treaty Organization has recently received much emphasis and support at all levels. NATO military commanders have agreed that their most pressing need is improved command and control. However, the problems of achieving a modern, unified C^3 system for NATO and its components also include some unusual difficulties.

NATO is an alliance of 15 separate, sovereign nations joined in a cooperative enterprise that makes decisions by committee. If one is aware of the difficulty of achieving a joint C^3 capability among the four services of the United States alone, then one can readily appreciate how difficult it is to achieve C^3 coordination among 15 NATO nations, each with its own services and unique problems.

One means of achieving unified C^3 is through improved interoperability. Interoperability is the ability of the C^3 system to operate as a whole, with data and information being exchanged throughout the C^3 structure. The main mechanism for achieving such interoperability within NATO is through the development of interoperability standards by a wide variety of NATO technical committees, panels, working groups, and agencies. These groups are generally slow to produce, but they do provide a vehicle for the nations of the alliance to represent themselves on these important matters.

Another means of improving C^3 is through the operational command structure. The major NATO commanders have responsibility for planning forces, determining requirements, and developing and operating systems that are fundamental to the creation of a NATO C^3 system. The NATO command structure is the only avenue available to integrate the hardware, software, and procedural aspects of command and control; therefore, the role of the NATO commanders in C^3 needs to be strengthened.

Industrial Considerations

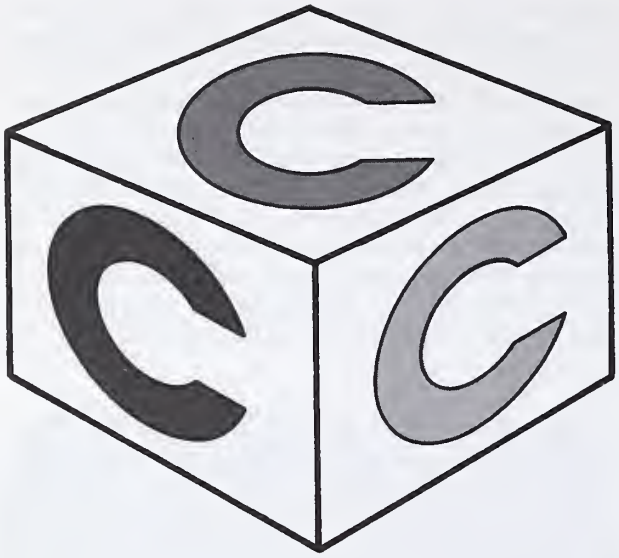
Whether in the U.S. or NATO, a modern C^3 system cannot be achieved without the involvement of industry. The U.S. does not have enough industrial people who can consider both the operational and technical aspects of C^3 systems, and even fewer who can apply this perspective to NATO. The allied nations themselves have, for a variety of reasons, proportionately even fewer people who make their professional living through understanding both technical systems and military operations.

European industry differs from American in several significant ways. For one, the Europeans have a briefer history of using high technology for military purposes. Further, in contrast to the U.S. economy, the European industrial sector and its intended market are more fractionated. Industrial practices and subsequent maintenance and logistics support concepts are also different in Europe, as are the statutes and regulations pertaining to industrial involvement with military systems. European practices for hiring and firing employees, financial disclosure, interlocking directorates, and cooperative arrangements vary from nation to nation. U.S. industry must by law engage in competitive bidding, but because of a smaller competitive base, European governments may often make direct arrangements with a firm for development and production of military hardware.

Figure 3. Areas Being Studied to Improve NATO C^3

- Strategic communications systems to connect many NATO nations, organizations, and military units
- Data-processing systems for both NATO organizations and national tactical units
- Tactical communications associated with national units earmarked for NATO use
- Maritime communications systems and command-and-control procedures
- Comprehensive management of air defense, air operations, and air-space control functions
- Warning and intelligence support for NATO political authorities, regional military commands, and national tactical units

To develop a successful C^3 capability, therefore, the alliance needs significant improvement in industrial cooperation across national boundaries. To encourage such participation, allied committees and agencies which set standards and approve common fund expenditures should be strengthened. And it cannot be overemphasized that the C^3 systems planning, design, and implementation capabilities of the NATO command structure must be increased. Use of such organizations as the NATO Integrated Communications System Management Agency and the



Supreme Headquarters Allied Powers Europe Technical Center should be expanded and new organizations created. NATO system-planning organizations and the industries supporting them should be more closely coupled, and procedures should be developed for transatlantic industrial cooperation in C^3. Toward this end, DoD is making a concerted effort to enter into bilateral and multilateral arrangements, while NATO's Conference on National Armaments Directions is attempting to establish cooperative C^3 procedures.

Current Initiatives

Of the many initiatives under way to improve NATO C^3, the most important are found in the recommendations of Task Force 6, a part of the NATO Long-Term Defense Plan. These proposals cover the areas shown in Figure 3 (see page 7).

As of this writing, specific mechanisms for implementing the long-term C^3 recommendations are not fully resolved. However, in those segments of the task force recommendation which essentially endorsed ongoing efforts, the implementation process is reasonably clear and demonstrates a variety of approaches.

Strategic communications is being implemented as part of the efforts of the NATO Integrated Communications Systems Management Agency. This organization provides for architecture, system design, acquisition, and configuration management. Participating nations contribute to a common fund for the acquisition and operation of the NATO communications system, and the agency follows a return-sharing formula in expending these funds. The responsibility for operating the system is vested in a central authority under the Supreme Allied Commander of Europe.

A different approach is being used in automatic data processing. Because there is no special agency for overall management of this function, each of the major NATO commanders manages his own system. The Supreme Allied Commander of Europe has organized a project office to design and implement a command-and-control ADP information system at his headquarters in Belgium. This office will award a contract for a systems-architecture study under NATO's international competitive bidding procedures. The European military command will acquire the system and operate it.

ADP and communications systems for national and tactical-level units will promote interoperability primarily through common standards and international cooperation on specific projects. NATO standard-setting committees and agencies must give each member nation an opportunity to meet a common NATO standard. In addition, international cooperation with industrial support on specific projects will aid in achieving interoperability. For example, agreements are being completed on technical characteristics to permit direct interoperability between the U.S. TRI-TAC system and the new, digital trunk networks being developed by several NATO nations. Another example is the proposed agreement by NATO to adopt compatible communications security equipment. Still another is the nine-nation agreement to participate in the Global Positioning System Project Office. Through this office, in which NATO representatives will work with U.S. personnel during full-scale engineering development, equipment standardization and interoperability of time-and-ranging navigation systems will be fostered.

The Future of C^3

Communications, command, and control systems reflect some of the most complex aspects of military planning and operations. New technology has created unprecedented problems and opportunities in C^3 which will require changes in organization and procedures. The attention, emphasis, and support provided current C^3 programs promise an eventual solution. It will be more difficult to improve the NATO C^3 capability, but we must try. A successful outcome in either the U.S. or NATO situation requires more involvement of industrial sectors. The C^3 challenge is great, but our security rests in large part on our ability to succeed. DMJ

DR. ROBERT J. HERMANN is the Principal Deputy Assistant Secretary of Defense for Communications, Command, Control and Intelligence. He also serves as the Deputy Under Secretary of Defense for Research and Engineering for C^3 and Intelligence.

CIVIL SERVICE REFORM:
"A World of Responsibility for Management"

*By Harold Brown, Secretary of Defense**

There is a sense in which it can be said that nothing in the Civil Service Reform Act is new—in fact, that far from being a display of inspiration and invention, it is an act of plagiarism from private industry.

Pay people according to their merit. Establish bargaining relationships by law rather than by executive fiat. In the private sector these are well-tried and widely accepted techniques. For any company president this is familiar ground.

But the challenge of the moment lies not so much in the ideas as in the inventive effort demanded to implement them. Never has so large a work force been asked to make so substantial an adjustment. By one single piece of legislation a system that has been in place for 95 years has undergone major change, and a new institutional technology has been authorized and demanded.

Just as your predecessors in 1883 were asked to make a new system work, you are now being offered the rare experience and responsibility of implementing innovation. The challenge is not whether you can adapt to someone else's technical invention, but whether you can invent the infrastructure that will give life to some very worthwhile ideas. In that regard, there are several respects in which the recent legislation will challenge government ingenuity.

Performance Appraisal

First, the legislation provides a charter for energizing the now-too-often pro forma practices of civil-servant performance appraisal systems by making them the basis for training, rewarding, reassigning, promoting, reducing in grade, retaining, and removing employees. This can yield rich rewards, because a good appraisal system can be an invaluable educational, motivational, and managerial device.

Note, however, that the act does not create appraisal systems, but a structure in which line managers and personnel directors can and must work together to design appropriate guidelines. Operations managers and personnel directors have not always worked hand in hand in the past. In devising and disseminating a fair and flexible performance evaluation system based on objective, job-related criteria, they now have a real reason and opportunity to do so. In this new environment, line managers will need to learn from personnel experts in order to select and tailor appraisal methods and approaches to the agency, position, and person involved. Personnel experts will need to pay careful attention to the substance of the jobs and values essential to the managers involved.

If this opens up a world of opportunity, it also involves a world of responsibility for management. If this appraisal system is to succeed, government managers must be able to establish criteria for employee performance, to convey those factors to the employee, and to judge the employee's performance against them.

Merit Pay

Second, the Reform Act links merit pay to performance appraisal. President Carter stated in his August roundtable discussion on civil service reform that he envisions the merit

---

***Secretary Brown delivered these remarks on October 23, 1978, at the Conference on Civil Service Reform, Ocean City, Maryland.**

pay provisions of this legislation as only a beginning. He hopes—and I can only add my voice to his—that the merit pay system for GS 13-15s will be a prototype, an innovation whose virtues will be so compellingly clear that the system will expand.

The attraction of the idea lies, of course, in its incentive effects. If managers are rewarded for the contributions that they and their subordinates make in productivity, quality of work or service, cost efficiency, and timeliness of performance, government will work better and be a better place to work. Again, however, the act merely creates opportunities. As in the across-the-board performance appraisals, performance standards for GS 13-15s must be generated by cooperation among senior managers, personnel directors, and middle managers themselves. This cooperation must be spiced by imagination and fortified by commitment.

The performance of middle managers in some cases may be difficult to assess; the will to translate evaluations into dollar terms may be hard for some to muster. When we require inventiveness to build a worthwhile system, we must recognize the risk that we may undermine the system by passivity, partiality, skepticism, or a misguided sense of egalitarianism. All workers do not perform with equal skill and dedication. It is not fair to the most productive to fail to recognize their superior service.

Senior Executive Service

The Senior Executive Service establishes a third area of challenge. The act provides for supergrade personnel management by the agencies themselves; it gives agency executives authority to reassign career employees without the long approval process that now characterizes the system.

Those who volunteer for the SES will be able to expand their managerial opportunities by moving wherever their skills are needed. This should help both the individuals involved and the agencies that benefit from their talents. To gain the reward, though, the persons involved must take risks. Lateral reassignment by design offers both risk and opportunity.

In some respects the challenges here are like those in the other portions of the bill. SES merit-pay provisions rest on performance appraisal. Goals that recognize responsibilities for making policy and establishing procedures must be set for and with the men and women in the SES. Since the rewards are potentially so great, you must make the most careful and creative use of evaluation and reward techniques. If we fail to establish relevant merit criteria and act on them, the SES will lose its vitality and become only an artificial construct.

If we do act wisely and well, the superior performance of the SES volunteer will be recognized by salary increases that open up substantial compensation possibilities. Base salary and bonuses are bounded only by the current $66,000 level of Cabinet positions. When combined with the impact such earnings have on retirement and similar benefits, the potential dollar value of federal executive service is significantly enhanced.

Grievance Procedures

When a group confronts the task of converting ideas into concrete procedures, risks and rewards abound in often unpredictable combinations. Can performance appraisals, especially of supervisors and managers, be made fairly and impartially? What is the risk of a reward system based on merit becoming exploited for political ends? Will a system that delegates so

"For all of us, it is an opportunity to participate in one of those rare watershed moments of social innovation. I should like it to be said that we did our part and did it well—that the government both functioned better and became a more professionally rewarding place to work through our efforts."

much authority to managers become a vehicle for favoritism? How much will employee desires be recognized? There are no certain answers to these questions at this point. Nor can there be.

However, a fourth area of innovation minimizes some of the risks. The act provides that employee-advocacy and adjudicative powers, both now vested in the Civil Service Commission, be separated into two independent agencies, the Office of Personnel Management and the Merit System Protection Board. The OPM is designed to promote efficient personnel management through examination, training, and administration of pay and benefits. The MSPB and its Special Counsel will investigate and prosecute abuses.

One important feature of the adjudicative legislation streamlines the appeals process. Nothing should be more desired by managers and employees alike. The legislation stipulates time limits for filing and settling grievances, and it protects both the employee and the manager by requiring documentary evidence of incompetence as grounds for separation. If the system works well, the performance appraisal process will itself contribute to the resolution of such questions.

An additional function of the MSPB is to protect the employee who in good faith "blows the whistle" on what he sees as agency mismanagement, waste of funds, abuse of authority, danger to public health or safety, and violations of laws, rules, or regulations. With such protection, employees can identify areas in which reform is needed.

With respect to labor-management relations, employee unions, and collective bargaining, the present act provides a Federal program grounded in law instead of executive order. The new law continues to protect the basic agency management rights established under the executive order. But the reform act expands employee and union rights by increasing rights to grievance and arbitration systems through collective bargaining. This expansion enhances the need for trained and talented management negotiators, a professional support staff, and an effective intramanagement communication system.

Efficient conduct of agency operations must ultimately be the objective of sound labor-management relationships. If we allow this to be eroded in the bargaining process, we will defeat the principal goal of civil service reform.

However, we should recognize that the bargaining process provides a real opportunity to create a better understanding and acceptance of agency policies and programs among employees. The labor-management process also encourages a joint solution of problems and improvement of operations. I think that a positive approach to labor-management relations would be to explore ways of working with employee unions to increase productivity. The investment of intelligence, skill, and patience in this test should result in major benefits for our agencies.

What I would emphasize to you again is that this is not self-executing legislation. Its potential benefits will be achieved only if we are all committed to making it work. Setting up the new system will involve an enormous commitment of time, energy, and imagination at all levels of management. The major effort involved in this conference is just the very beginning.

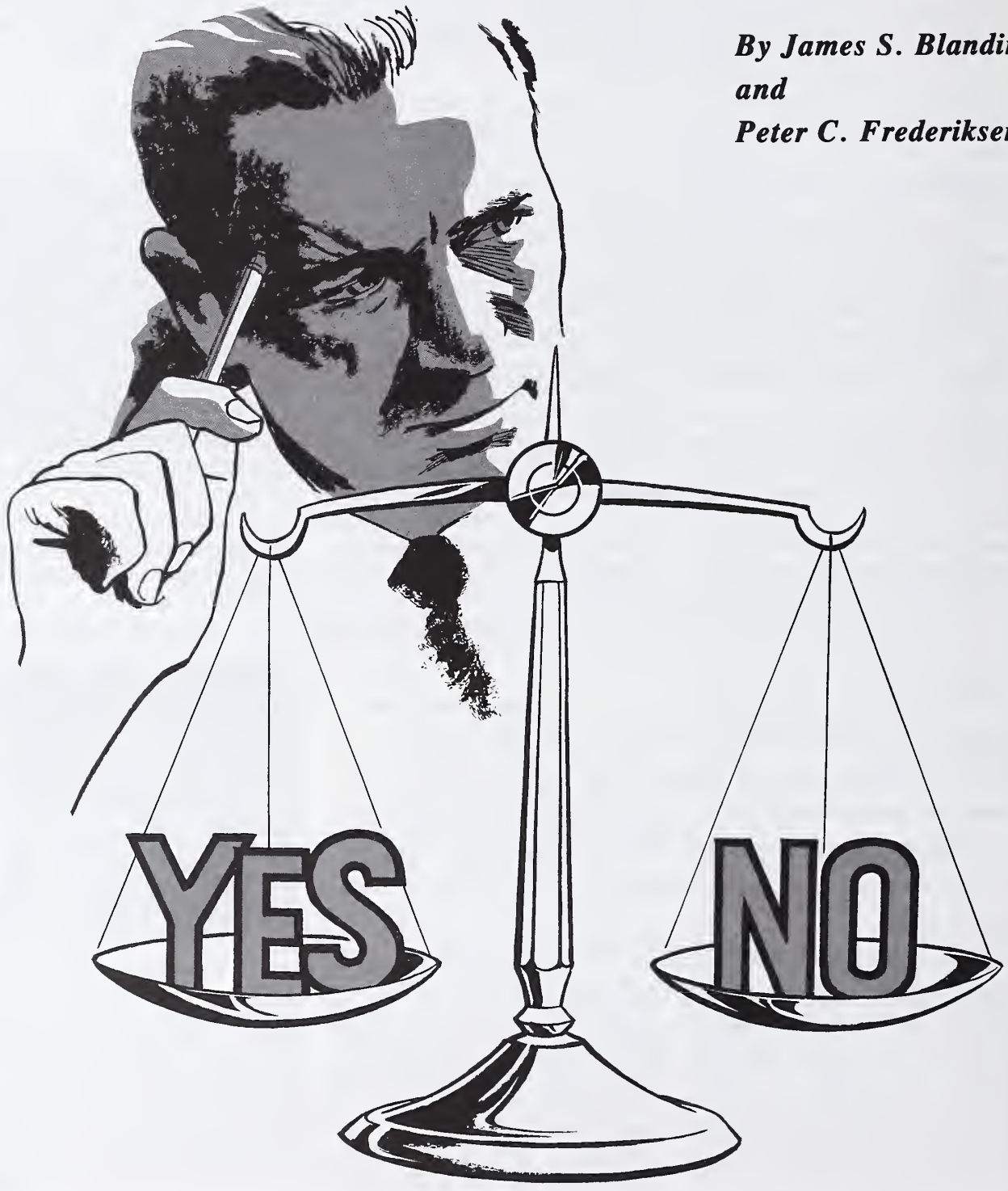
It is, however, an exciting beginning. For all of us, it is an opportunity to participate in one of those rare watershed moments of social innovation. I should like it to be said that we did our part and did it well—that the government both functioned better and became a more professionally rewarding place to work through our efforts.

DMJ

"Operations managers and personnel directors have not always worked hand in hand in the past. In devising and disseminating a fair and flexible performance evaluation system based on objective, job-related criteria, they now have a real reason and opportunity to do so."

The Role of Discounting

By James S. Blandin
and
Peter C. Frederiksen



in Problems of Choice

Is discounting appropriate where managers, operating within fiscal constraints, are tasked with maximizing effectiveness? This article presents yet another point of view on the issue.

An article which recently appeared in the *DMJ*[1] posed the question, "Should Defense Managers Discount Future Costs?" The author reached two main conclusions. On the one hand, if managers operate in a management environment where they are required to provide specific levels of effectiveness and are not fiscally constrained, then discounting is "proper." On the other hand, if managers work in an environment of fiscal constraints and are tasked with maximizing effectiveness, ". . . then the present requirement to discount future costs is inappropriate."[2]

While we wholeheartedly agree with the first conclusion, we cannot fully support the second. In our estimation, to conclude that the question of discounting has a clear-cut answer, depending on the management environment, can be very misleading. For managers who operate under conditions of fiscal constraints, we believe the answer to the question of discounting should be at least "perhaps" rather than an unqualified "no."

The Role of Discounting in Analysis

The primary role of discounting in analysis is that of providing information to aid the decision maker in the difficult problems of choice. Discounting does not provide the solution to choice problems. Rather, discounting is one of many management tools that can be used in conjunction with the manager's judgment, experience, and projections of economic and political climates in making the final choice among alternatives. In this light, it is unfortunate that many managers think of discounting as a requirement rather than as an aid in decision making.

Discounting does not decide questions of feasibility; instead, it provides information on preferability. As an illustration of this point, imagine a manager in the Department of Defense faced with a rigid budget constraint next year of $100. Next year's costs are expected to be $101. Discounting the $101 will diminish its present cost, but that will not keep the expected future costs within the $100 budget. We know of no tool, even in the academic world, that will allow you to spend $100 next year for something that costs $101. It makes no difference whether you discount both the budget and costs, or look at them in next year's dollars. Irrespective

Figure 1. Equal Effectiveness, But Unequal Cost

Year	Fiscal Constraints	Undiscounted Cost for Alternative A	B	C
1	$100 (budget)	$105	$100	$ 75
2	$100 (program)	$100	$100	$100
3	$100 (program)	$100	$ 75	$100
Total undiscounted cost (constrained = $300)		$305	$275	$275
Total cost at 10% discount (constrained = **$261**)		**$266**	**$241**	**$237**

[1] *Rolf H. Clark, "Should Defense Managers Discount Future Costs?"* Defense Management Journal, *March 1978, pp. 12–17.*
[2] *Ibid., p. 13.*

Figure 2. Unequal Effectiveness And Unequal Cost

Year	Fiscal Constraints	Undiscounted Cost for Alternative A	B	C
1	$100 (budget)	$105	$100	$ 75
2	$100 (program)	$105	$100	$ 75
3	$100 (program)	$100	$ 90	$ 75
4	$100 (program)	$100	$ 80	$ 90
5	$100 (program)	$100	$ 70	$ 90
Total undiscounted cost (constrained = $500)		$510	$440	$405
Total cost at 10% discount (constrained = **$398**)		**$407**	**$356**	**$319**
Effectiveness		.98	.96	.94

of the technique employed, the $101 option is infeasible for the manager under such an unalterable budget constraint. Discounting is not intended to decide questions of feasibility, but rather ones of preferability once the feasible alternatives are known.

The Role of Discounting in a World of Fixed Budgets

In examining the role of discounting for managers working under fiscal constraints, one can conclude that there are indeed certain conditions under which discounting is not useful and some conditions under which the tool can yield valuable information on questions of preferability. Consider again our hypothetical manager faced with a budget constraint. If his feasible set of alternatives consists of only one system, the discounting issue is irrelevant. Discounting is also irrelevant if our manager has to make a choice between a number of equally effective systems whose cost streams are only for one year. For example, if the budget for next year is $100 (or any amount equal to or greater than $95) and there are three equally effective alternatives, A, B, and C, costing $90, $95, and $95, respectively, alternative A is always preferred on economic grounds.

However, if we modify the above example somewhat, discounting can provide some useful information. Imagine the conditions presented in Figure 1 (see page 13), where we assume that the effectiveness of each alternative is equal and sufficient both in terms of magnitude and timing. Alternative A is infeasible since costs (whether discounted or not) exceed the budget (whether discounted or not). Alternatives B and C both are feasible from a budget-constraint viewpoint, so the question now becomes one of preferability. Discounting the cost streams at 10 percent for alternatives B and C shows that the present values are $241 and $237, respectively, and alternative C would be the preferred choice. Yet, the value of discounting to the manager is even more apparent if, for example, the first year's costs for alternative C were increased by $2 to $77. The total undiscounted costs for B and C are now $275 and $277, the discounted total costs $241 and $239. Alternative C would still be preferable.

Let us pose a more realistic example. Consider three alternative radar systems, each having different cost streams over time and each becoming operational in the fifth year, but with different levels of effectiveness. (The latter might be distinguished by the varying probabilities of detection and tracking for some specified duration.) The costs and benefits of the three systems appear in Figure 2. As before, alternative A is ostensibly infeasible due to the budget constraint, despite the system yielding the highest level of effectiveness. The other feasible alternatives, B and C, have different cost streams and different levels of effectiveness. Using the sole criterion of greatest effectiveness to determine preferability, system B is chosen since it has a .96 probability of detection and tracking versus .94 probability for system C. In this case, discounting is irrelevant. Once the manager has identified feasible systems within the budget, costs can be ignored if and only if the choice is aimed at maximizing effectiveness. Costs and the timing of costs are irrelevant only when the decision rule is to maximize effectiveness within the feasible budget.

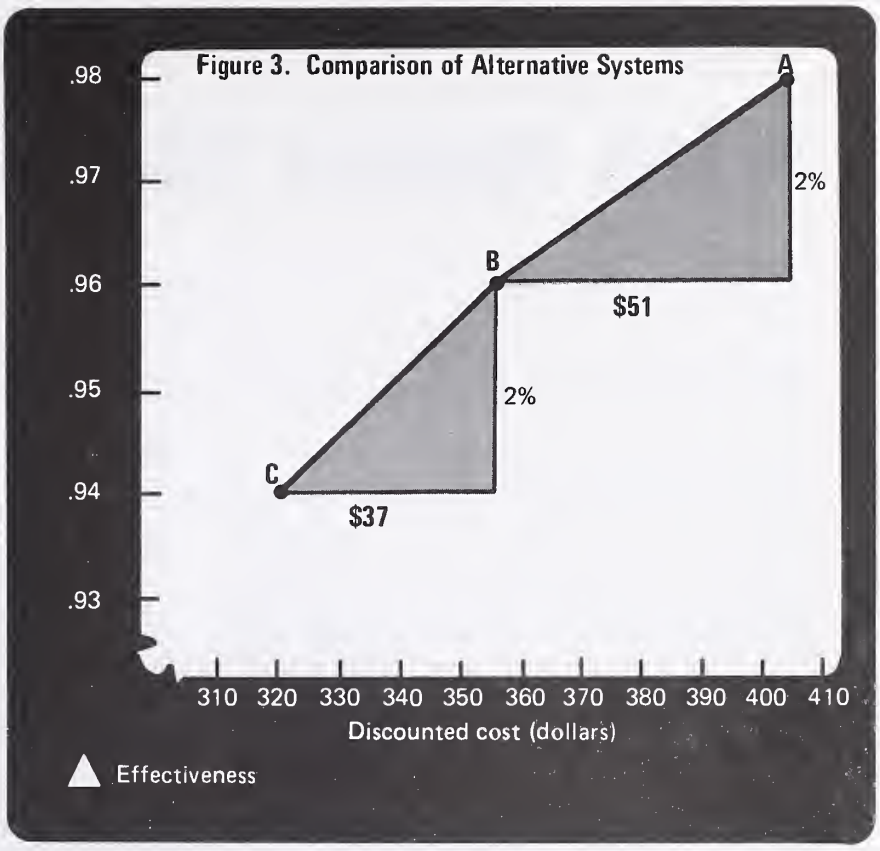
As indicated by the above examples, the answer to the question of discounting future costs is "perhaps." The usefulness of discounting depends on program cost constraints, the number of alternatives, effectiveness levels, and the investment-time horizon faced by the manager. Each factor may serve to constrain the choice problem to such a degree that the discounting issue may become irrelevant. But what about the role of discounting in a less constrained environment?

An Expanded View

Effective resource allocation calls for decision makers to examine both benefits and costs among competing alternatives. While fiscal guidance may constrain the decision problem, it should

not limit the thinking process about problems of choice. In reality, future budgets or program costs are guides or targets; they are institutionally subject to manipulation, reallocation, and reprogramming. These very characteristics require decision makers ultimately to make value judgments on costs and benefits among competing alternatives.

For example, return to our choice problem given in Figure 2. Simple calculations show that the discounted cost difference between alternatives B and C is $37 ($356 - $319). For this additional cost, the additional effectiveness is 2 percent. Similar calculations can be performed between alternatives B and A, the heretofore infeasible alternative, where the added cost is $51 and the added benefit is 2 percent. These results appear in Figure 3.



In a decision-making context, three general types of value comparison questions can be asked. Collectively they represent the essence of resource allocation.

First are the questions involving the value comparisons among systems. In our example presented in Figure 3, are the added benefits of a 2-percent increase in effectiveness worth the additional discounted cost of $37 between alternatives C and B? Are the added benefits of a 2-percent increase in effectiveness worth the additional discounted cost of $51 between B and A?

Second are the questions involving value comparisons within a given system. For system C in our example, what would the marginal cost be to increase its effectiveness from .94 to .96 or .98? Would these expenditures be worthwhile? The same type of questions could be asked relative to systems B and A.

Third are the questions involving value comparisons among alternative programs. Should any funds be allocated to one of our candidate radar systems, or would the total defense capability be relatively enhanced by allocating these funds to some other competing defense program?

In reality, it may be naive to view fiscal constraints as rigidly as we did in our examples. Even current operating budgets provide opportunities for reprogramming funds. Clearly, such fiscal rigidity does not exist in the planning, programming, and budgeting process in DoD. The services and the Joint Chiefs of Staff not only have an opportunity to review and comment on the aggregated and minimally "fenced" fiscal constraints expressed in the consolidated guidance early in the planning, programming, and budgeting cycle, but they also prepare the Program Objectives Memoranda and participate in the issue-paper process leading to the Program Decision Memoranda of the Secretary of Defense. Finally, the services and the JCS participate in the Program Budget Decisions leading to the development of the defense portion of the President's budget. Even after completion of annual planning, programming and budgeting, the JCS and the services continue to have opportunities to testify in the Congressional deliberation process on the Defense budget. The authorization and appropriations acts treat aggregated areas so that opportunities for trade-offs within these categories continue to exist in the budget-execution phase.

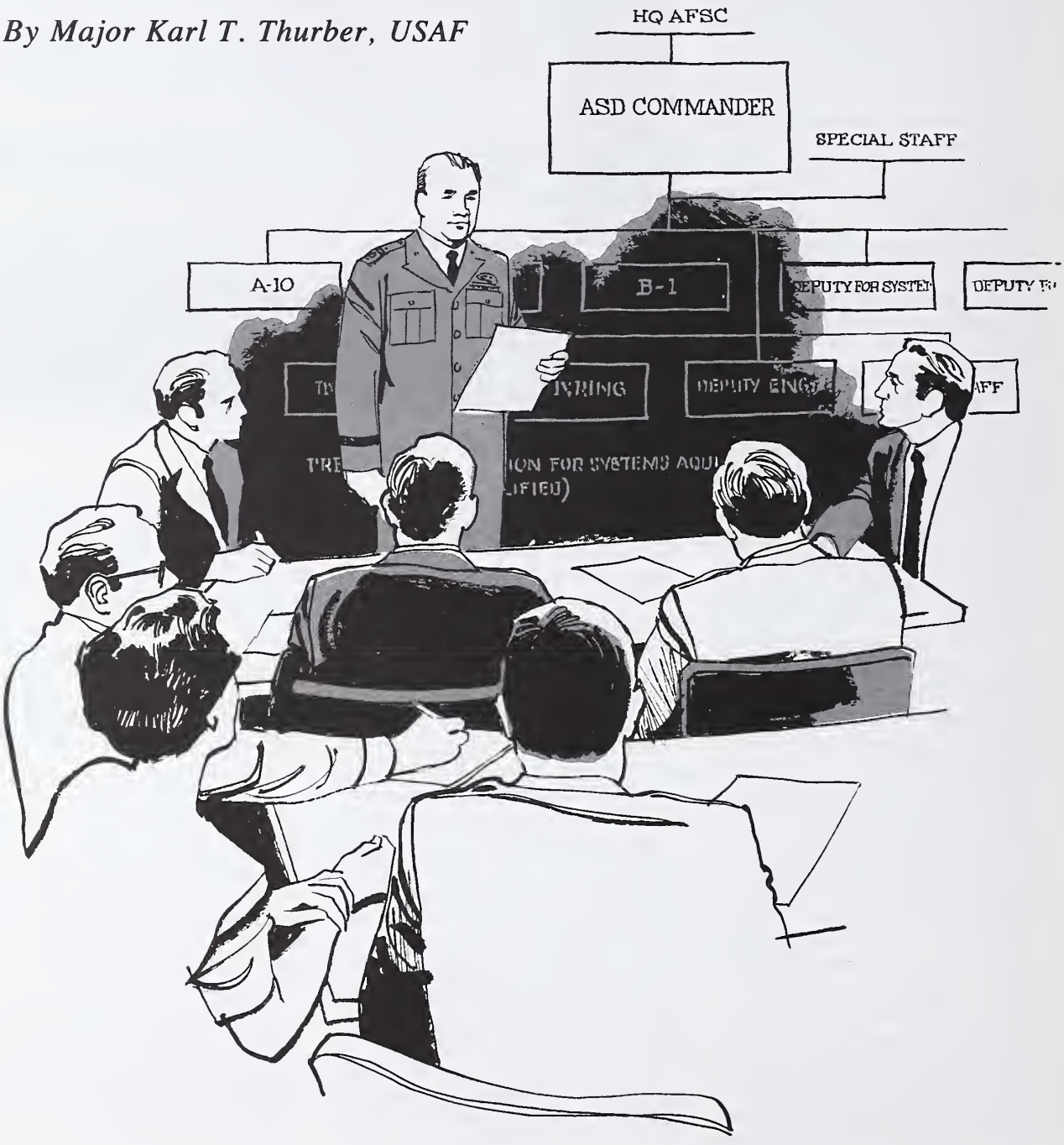
Each of these points of participation in the budget formulation and execution process requires that value-laden trade-offs be made. These judgments, in turn, hinge critically on the relative comparison of costs and benefits over time among the many alternatives. Discounting allows us to deal systematically and objectively with the crucial time dimension of these resource allocation questions. DMJ

DR. JAMES S. BLANDIN is an Assistant Professor of Management at the Defense Resources Management Education Center, Naval Postgraduate School in Monterey, California.

DR. PETER C. FREDERIKSEN is an Assistant Professor of Economics at the Defense Resources Management Education Center, Naval Postgraduate School in Monterey, California.

The Air Force's Experience With Matrix Management

By Major Karl T. Thurber, USAF



A model program in the Aeronautical Systems Division at Wright-Patterson Air Force Base, Ohio, may point the way for future public-sector applications.

At first glance, the concept of matrix management is curious at best. After all, working for one boss is trying enough, but the thought of working for two bosses—one for the special program office you're assigned to, and one for the functional area you're in—can be a bit disconcerting. Additionally, such a philosophy is contrary to the traditional military concept of the chain of command, whereby orders are taken only from one's immediate superior.

But don't hasten to discard the concept. Matrix management, pioneered in the early 1960s by several major aerospace firms and Dow Corning Company, offers operational flexibility and seems particularly well suited to acquisition activities. Government organizations and activities involved in acquisition are showing renewed interest in the matrix management concept. The Air Force, for example, has found the approach especially useful in program offices.

Traditional Organizations

The most familiar organizational structuring is done along *functional* lines. Organizing by function means that all work is grouped into major functional or specialized departments, each headed by one manager. Functional departmentalization is logical, takes advantage of occupational specialization, and promotes coordination among members of a functional area.

However, as the organization grows and diversifies its activities, these advantages can quickly turn to disadvantages. Frequently, functional organizations become too centralized, mired in layers of management, difficult to control, and devoid of good internal communications. Such a structure is not a good training ground for balanced, well-rounded managers, because it leads to a high degree of functional specialization which often inhibits career growth by fostering overspecialization and parochial decision making.[1]

It is logical to have functional structuring in new, small organizations, but when they grow and diversify, other designs, such as *project organization,* become appropriate. As an organization develops, management may adopt this type of structure in order to place all the necessary functional specialists for a program under one manager. Authority is vested in the project or program manager, and the functional specialists support him. Many aerospace companies, government agencies, and military systems-acquisition activities have adopted this form of organization. Project organization has two distinct advantages over functional organization: it is more responsive to schedule and budget demands, and it can react to unexpected demands without adversely affecting other parts of the organization.

Project organization, however, is not without its drawbacks, one being that there is usually inadequate emphasis within the project office on the career development of the functional specialists who support it.[2]

The Matrix: A Hybrid

If complex organizations rely completely on functional structure, the work may fall behind because it is difficult to discriminate between the relative priority of various projects. On the other hand, technological progress may suffer if they rely exclusively on project organization when their functional disciplines are so widely separated that it hampers the interchange of information.[3] These problems are considerably reduced under matrix management. It seems particularly applicable to organizations requiring specialized resources in an environment that demands a close integration of projects or programs.[4]

Matrix management is a hybrid of project and functional structuring. Functional managers report to a particular central authority for such technical disciplines as engineering, procurement, and finance, while project managers also report to an overseeing common official but have functional or technical specialists assigned directly to them for day-to-day tasking. Thus, in matrix

[1] *T. Haimann,* Professional Management, Theory and Practice *(Homewood, Illinois: Irwin, Inc., 1973).*

[2] *Lt. Col. Francis L. Siau, USAF, "Organizational Structures: Matrix Management Applications," Air War College Report No. 6061, Maxwell AFB, Alabama, April 1976.*

[3] *Ibid.*

[4] *Jay R. Galbraith,* Designing Complex Organizations *(Reading, Massachusetts: Addison-Wesley Publishing Co., 1973).*

MATRIX MANAGEMENT

organizations there are two lines of authority: horizontal through the program managers and vertical through the functional managers. Project managers are still responsible for their projects, but they must now depend on coequal functional-staff managers to provide them with specialists (Figure 1 shows the interrelationships in a matrix oganization).

Among the benefits of matrix management are increased organizational responsiveness, fast but sound decision making, increased potential for comprehensive and integrated planning, more equitable allocation of personnel, and uniform training opportunities. Functional specialists assigned to program offices may also experience a new sense of independence and professionalism by being somewhat removed from the direct supervision of a program manager.

One important advantage of a matrix-structured organization is its ability to respond to change. The structure of old organizations can be readily modified, and personnel can be moved about rapidly as workloads and priorities change. This is often necessary when new programs are born and old ones mature and wither.

Matrix management is not without its problems, however. For example, working for two bosses is an oddity for most people and requires an atmosphere of genuine trust and confidence. In addition, functional and project managers must communicate with each other and have a proper measure of authority, responsibility, and accountability. Working for two bosses may tend to generate conflict and confusion over who does what for whom.

Matrix Management in Air Force

Despite these drawbacks, matrix management has been implemented in many program and project offices of the Air Force Systems Command. These offices rely principally on project management; however, rapidly changing workloads and the necessity for capable, highly trained, functional specialists have dictated the need for an alternate form of organization. Indeed, there are definite reasons why the Air Force Systems Command has considered the matrix concept.

Traditional forms of management and structuring work well for most organizations with clear, well-defined missions. But when the tasks are highly complex and interrelated, pressures arise which force management to consider alternate approaches like the matrix. When tasking becomes extremely complex, failure to adopt a tailored organizational structure may cause operational delays. This is particularly true where there is a proliferation of competing projects.[5]

In military circles, however, there has been a great deal of resistance to this type of organization. Project and program managers often complain that they are still responsible for overall mission accomplishment, despite having been stripped of all authority over the functional personnel who once supported them. In addition, matrix management is a far cry from the conventional military chain-of-command concept. Overcoming this resistance is essential.

Can matrix management really work in military organizations? An Air Force experiment conducted by the Aeronautical Systems Division at Wright-Patterson Air Force Base, Ohio, may provide the answer.

Following a classic model of program management, the Aeronautical Systems Division, which manages the acquisition of most aircraft and related support systems for the Air Force, had all of its functional specialists, except engineers, assigned to support specific program offices. Despite being responsible for specific functional areas under the ASD commander, staff agencies mainly performed technical and coordinating tasks. These agencies neither managed the functional support personnel directly assigned to the program offices nor challenged the business-management acumen of the program directors.

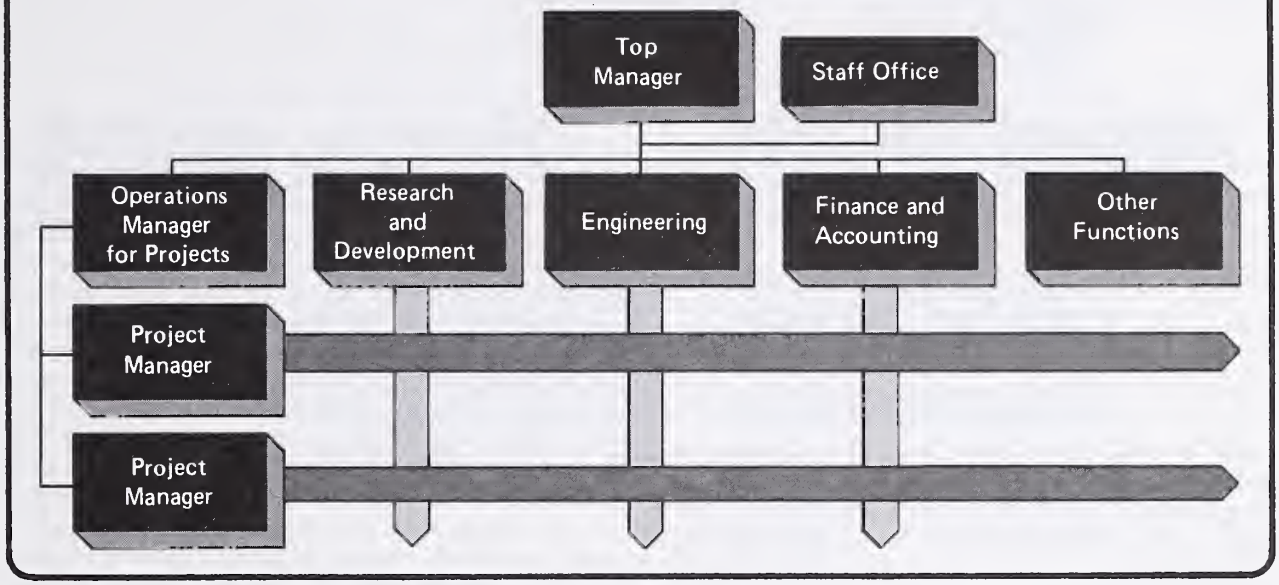
By 1975, the emphasis on the self-contained program offices and the rapid expansion of new ASD programs had led to a large number of autonomous special program offices, each with its own cadre of functional specialists. As new aircraft went into production, the workload increased dramatically; however, there were constraints on the number of personnel to be assigned. The Air Force was concerned about personnel-overhead costs of the self-contained program offices. the insularity of many of the programs, sluggish organizational responsiveness to workload shifts, and inadequate professional development in the functional skill specialties. Of special concern was whether the fragmented, business-related functions such as procurement and financial management were truly effective.

ASD "Goes Matrix"

To address these concerns, the product divisions of the Air Force Systems Command, which included the Aero-

[5] *Jay R. Galbraith, "Matrix Organization Designs,"* Business Horizons, *February 1971, pp. 29-40.*

Figure 1. The Vertical and Horizontal Flows of Functional Authority in a Matrix Organization



nautical Systems Division, began to reorganize in early 1976. Emphasis was placed on strengthening and enhancing the business functions in the acquisition process. The reorganization was intended to create a forum for the cross-feeding of innovative and sound business-management techniques among the program offices, and to strengthen the coordination and integration of career-development programs for military and civilian functional-support personnel.

To achieve these objectives, the functional staff offices were given line authority over the support specialists (see Figure 2 on page 21). The special program offices no longer had any personnel authorizations for the support specialists who worked for them and instead relied on the functional staff offices for personnel allocations to meet their needs. Thus the functional organizations had to balance the frequently conflicting workload requirements and personnel demands of the program offices, and at the same time ensure availability of the functional specialists needed by the functional-area directors.

For administrative purposes, the functional staff specialists are formally assigned to home offices within each functional-staff organization. The special program offices must negotiate with the home offices for support personnel. When support personnel are assigned to special program offices, they are called collocates, indicating that they report to their respective special program office for operational matters and to their respective home office for administrative and career-development matters. Each special program office has a key senior collocate who is the chief representative of his home organization. He is a two-boss manager, reporting to both his special program office and to his parent home organization.

To sort out the myriad responsibilities of all the players in such a complex organizational scheme, the Aeronautical Systems Division issued a comprehensive regulation,[6] detailing the roles, responsibilities, and operational rules followed under matrix management. Understandably, the dual-reporting structure added a new degree of complexity to the conduct of business. Under the previous structure, program offices had primary responsibility for all their personnel. Now, many responsibilities were transferred to the home organizations or were shared. Some of the areas of responsibility which had to be redefined were personnel, recruitment, award programs, and career development. In each case, it had to be determined whether the special program office or the home organization would be the higher authority for the matrixed personnel.

Perhaps matrix management's most sensitive feature is the handling of efficiency reports and performance appraisals. The two-boss situation belies the conventional logic that an individual should work for and be evaluated by one boss. This is a sensitive area for military personnel, for whom the basic concern is who will rate matrixed officers and airmen. Because these evaluation systems do not provide for such complex reporting arrangements, a decision must be made to route the reports through either the special program offices or the home functional offices. At the Aeronautical Systems Division, military reports were routed through the special program offices, and civilian performance appraisals are reviewed by the

---

[6] *Air Force Systems Command, Aeronautical Systems Division Regulation 30-2, "Management of Collocated/Dedicated Personnel," June 1977.*

home functional organization. Thus, while military evaluations were effectively controlled by users, civilian appraisals are controlled by home organizations. Obviously, the determination of such routings is critical and, if perceived as unfair, may cause considerable employee dissatisfaction.

In the Aeronautical Systems Division, routing channels for personnel evaluations were determined by negotiations between the major special program offices and the functional organizations. This resulted in a local regulation being published prior to matrix implementation. Drafting this regulation was greatly facilitated by the experience of the Office of the Deputy for Engineering, which had operated on a limited matrix basis within the Aeronautical Systems Division since 1964.

Pros and Cons

The question remains: Is this approach living up to expectations? In general, it is, although it neither resulted in immediate manpower savings, nor instantly solved the many problems associated with integrating and professionalizing the various functional disciplines within program offices. However, the switch to a matrix management structure did help the Aeronautical Systems Division to better utilize its resources. Among the main benefits were:[7]

- Rapid reallocation of personnel to meet program demands.
- Enhancement of professional communication among the special program offices.
- Cross-feeding of innovative management techniques.
- Exchange of lessons learned.

Most important, each of the functional deputies was now in a better position to assert a cohesive, division-wide stewardship of his discipline and to raise a much stronger voice in the business-management decisions of the program offices.

Although matrix management helped the Aeronautical Systems Division cope with the increasing complexity of its systems-acquisition process, there were some disadvantages that suggest the need for caution in its application to other organizations. Indeed, the price paid for increased organizational flexibility is increased organizational uncertainty. For example, when people work for two bosses or support two organizations, some experience a continuing identity crisis over what organization they really work for. Also, many program directors tended to resent the matrix, because they perceived their power as diminished and disliked negotiating with the functional home organizations and competing with other program directors for personnel allocations. As a result, particularly on key personnel issues, there was a tendency for polarization of viewpoints as some senior managers simply considered the matrix concept unworkable.

To alleviate such problems, the Aeronautical Systems Division allowed program directors to retain their authority in making important program-management decisions. However, program offices often worked together with the functional-support offices to make joint decisions in functional-specialty matters, particularly those involving personnel. In a few instances, problems were passed on to the commander of the Aeronautical Systems Division for resolution. Despite their initial distrust of the matrix structure, managers encountered relatively few problems that had to be referred to the commander for resolution.

Not surprisingly, the routing of personnel evaluations was a major concern to managers and workers alike. Many collocates resented the tug-of-war over their evaluations and sometimes felt that the system worked to their disadvantage. Some collocates even considered themselves the second-class citizens of their special program offices, feeling as though these offices no longer had any real responsibility for them and that the distant home offices to which they were now directed for career management and professional development tended to consider them as mere pawns on a chessboard.

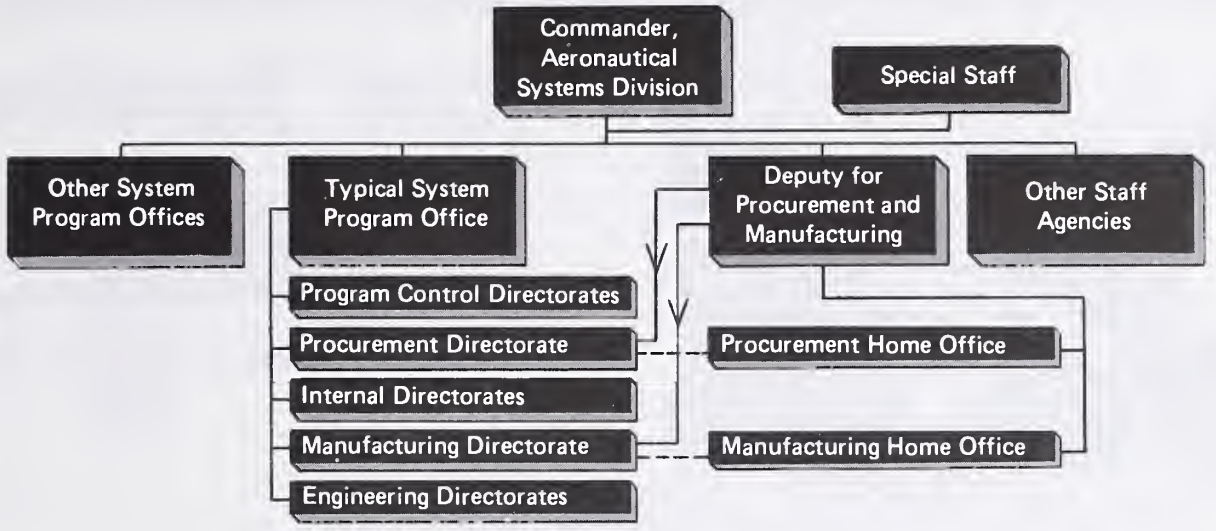
These feelings of second-class status were not widespread, however, and most collocates eventually saw the potential for career development and professional enhancement generated by the new structure. Because they were more accustomed to a stable working environment, civilian workers were perhaps more averse to the new structure than were their military counterparts. Military personnel who resented the matrix structure were more concerned about the increased complexity of the officer-evaluation report system.

What is the bottom line on ASD's matrix management experience? Evaluations by the Air Force Systems Command and the Aeronautical Systems Division indicate that matrix-management objectives are being met, but that fine tuning of the system is needed. In fact, it may take three years to develop a highly effective matrix or-

---

[7]*Col. Robert L. Zambenini, USAF, "ASD Implements Matrix Concept,"* The Air Force Comptroller, *July 1977, pp. 40-41.*

Figure 2. Simplified Post-matrix Organization in the Aeronautical Systems Division



Note: Only the matrix relationship of the Deputy for Procurement and Manufacturing is shown here. Similar relationships exist with respect to Engineering and Comptroller.

ganization. Certainly, the full impact and benefits of matrix management have not yet been realized. Clearly, any organization that sets up such a complex structure will find that operating relationships must be continually refined and its viability continually promoted.

Government Future for Matrix?

Although matrix management conflicts with traditional precepts of military organizational discipline, it can be useful when applied to business-management missions or to an activity tasked with accomplishing multiple, complex, and changing projects.

While matrix management does not appear to represent the wave of the future for military organizations, it will help certain kinds of organizations to become more flexible and to develop tailored structures to meet goals. Air Force organizations have to respond to the multiple aspects of their missions and make do with fewer resources, particularly personnel.

Outside the systems acquisition arena, there are possibilities for applying matrix management to the base and unit level. For instance, navigators and other nonpilot aircrew members within Air Force flying organizations might find that matrices are practical alternatives to traditional chain-of-command structures. This may encourage professional development in such aircrew specialties as electronic warfare, weapons-system operation, and navigation. Such base-level functions as supply, transportation, life support, maintenance, and logistics may also be suited for application of matrix management. By drawing on the experience gained from systems acquisition, one may reasonably expect present systems of matrixing to be refined and improved.

Matrix management can be applied not only to personnel within an organization but also to those of different organizations. For example, the relationships among the Joint Chiefs of Staff, the services, and the Defense agencies may be considered matrices. The dealings between functional commands based in the continental United States and overseas gaining or using commands, ties between joint and multinational commands within NATO, and the dealing of many support commands and agencies with project or mission-oriented user organizations may also be viewed as matrices.

Although matrix management is not a panacea, it does hold promise for harassed managers in organizations with complex and changeable tasks. As Jay R. Galbraith once said, "For most organizations, the matrix design is the most effective alternative. Managers must be aware of the different kinds of matrix designs and develop some basis for choosing among them."[8] Used properly, the matrix structure can bridge the two traditional management structures and help organizations meet their objectives and promote the professional development of their work force. DMJ

MAJOR KARL T. THURBER, USAF, is an Electronic Warfare Systems Officer and Chief of Administration at the 8th Special Operations Squadron, Ft. Walton Beach, Florida.

This article evolved from a research paper written by Major Thurber while he was attending the Air Command and Staff College.

---

[8] *Jay R. Galbraith, "Matrix Organization Designs," pp. 29-40.*

Time Out From Tension

By Ruanne K. Peters and Herbert Benson

There is new evidence that learning to relax can lower blood pressure and raise one's efficiency.

Modern society has undergone rapid technological progress, and the business community has played an integral part in this change. Like the rest of society, the business world has had to adjust behaviorally to both the beneficial and the deleterious effects of a fast pace and a pressured life.

These behavioral adjustments are emotionally and physiologically stressful, and they lead to undesirable effects on health and well-being. Elevated blood pressure resulting from stress is perhaps the major predisposing factor in the development of heart attacks and strokes.[1] Excessive mental irritability and anxiety are still other common manifestations of stress.

Although awareness of these physiologically and psychologically harmful effects of stress has been increasing, few individuals know how to alleviate them. In fact many business executives, victimized by the stressful world they have helped create, have come to accept excessive stress as a necessary element of their lives.

There is a very simple way for many individuals to deal with stress and thus to prevent it or at least control many of its damaging effects: to elicit "the relaxation response." This is an innate physiologic reaction, characterized by decreases in metabolic rate, heartbeats, and breathing rate.

A person can bring forth the relaxation response by practicing any one of a number of simple techniques. Many of these have existed for centuries, mostly in the form of religious meditation and prayer. Recent investigations have demonstrated, however, that the relaxation response may be elicited by various secular techniques as well. Four elements common to all these techniques are a relatively quiet environment, a comfortable position, a repetitive mental stimulus, and a passive attitude.[2]

For a technique we have found practical, see the box on page 25.

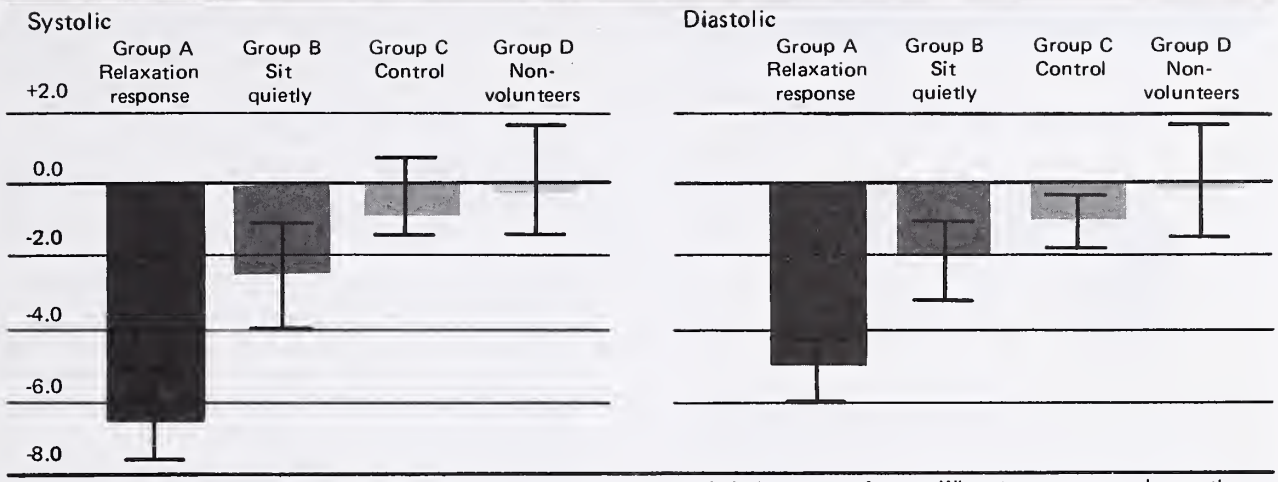
Learning to Relax

Since the majority of the adults in the United States spend at least half their waking hours at work, the working environment represents a logical place to schedule time for eliciting the relaxation response. Not only

[1] *See Mary C. Gutmann and Herbert Benson, "Interaction of Environmental Factors and Systemic Arterial Blood Pressure: A Review,"* Medicine, *November 1971, p. 543.*

[2] *See Herbert Benson,* The Relaxation Response *(New York: Morrow, 1975); and Herbert Benson, "Your Innate Asset for Combating Stress,"* Harvard Business Review, *July-August 1974, p. 49.*

Figure 1. Mean Change in Blood Pressure (in millimeters of mercury)



Note: Standard error of the mean is a statistical measure of range. When two ranges overlap, as the mean changes for Group B, C, and D in Exhibit I do, the changes are not statistically significant. Since the range for Group A does not overlap with these other groups, this change is statistically significant. The standard error of the mean appears on the rest of the exhibits in this article.

would an individual benefit from lessening the harmful effects of stress, but business would benefit from improving the health and well-being of its staff. We investigated whether relaxation response breaks, taken within the occupational setting, can alleviate the undesirable manifestations of stress.

A recent 12-week study tested the feasibility and usefulness of voluntary relaxation response breaks in such a setting. The investigation was conducted at the corporate offices of Converse, a division of Eltra Corporation, sponsored by the Converse Management Association and coordinated by Alan Zimmerle, supervisor of accounts payable. Grants from the U.S. Public Health Service and from the General Service Foundation supported the project.[3]

In the spring of 1975, brochures describing the proposed investigation were distributed to the 428 corporate employees working at the corporate offices of Converse in Wilmington, Massachusetts. Of the employees, 140 volunteered to participate in the study.

From the Converse employees who did not volunteer, 63 "nonvolunteers" were selected randomly and asked to help evaluate the program. Only 9 of these nonvolunteers refused to cooperate. The volunteers and the nonvolunteers, 54 percent of whom were female and 46 percent male, had about the same demographic and personal characteristics. Their average age was 33.4 years, 23 percent of them held managerial or supervisory positions, 29 percent were technical specialists, and 63 percent were married.

The volunteers agreed to keep daily records for 12 weeks and to attend seven biweekly sessions, during which they would fill out questionnaires and have their blood pressures measured. The nonvolunteers agreed to have their blood pressures measured and to complete questionnaires only at the beginning and at the end of the study.

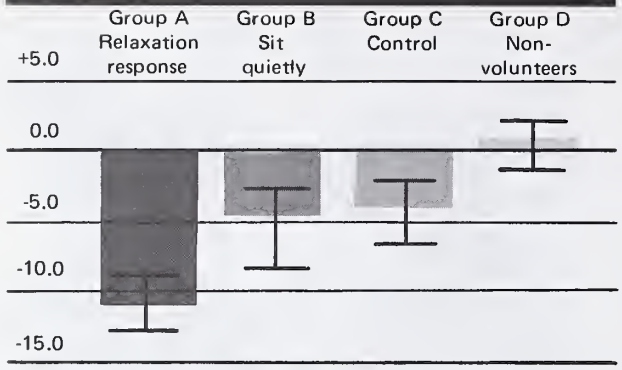
Gathering Data

After four weeks of baseline measurements and before any relaxation instruction, the volunteers were divided on a random basis into Groups A, B, and C. The nonvolunteers were kept together and labeled Group D. The randomization procedure for the first three groups assured virtually equivalent groups at the outset and eliminated major biases that might have influenced the results. Only Group A was taught the technique of eliciting the relaxation response. Group B was instructed simply to sit quietly and relax. Group C received no instructions concerning relaxation and was told to follow its usual schedule. Group D, the nonvolunteers, also received no instructions and was asked to go about its customary work, but unlike the other three groups, it attended only two measurement sessions.

In the subsequent eight weeks, Groups A and B were asked to take two 15-minute relaxation breaks every day: one in the morning and one in the afternoon or evening. During these breaks, Group A practiced the relaxation response technique, and Group B was asked to relax without the use of any particular technique. Groups C and D took no relaxation breaks. The company set aside a quiet room with comfortable chairs for the participants

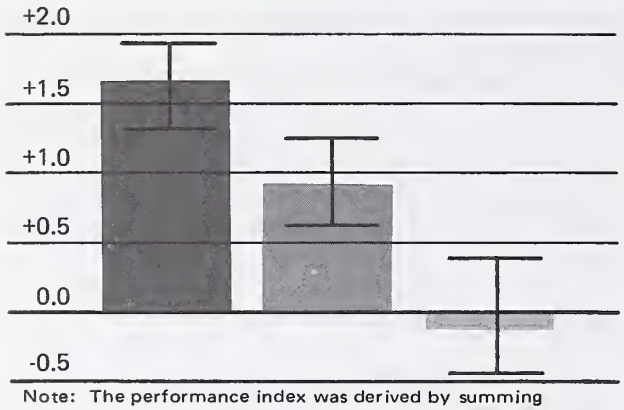
[3] *See Ruanne K. Peters, Herbert Benson, and Douglas Porter, "Daily Relaxation Response Breaks in a Working Population: I. Effects on Self-Reported Measures of Health, Performance, and Well-Being," and Ruanne K. Peters, Herbert Benson, and John M. Peters, "Daily Relaxation Response Breaks in a Working Population: II. Effects on Blood Pressure,"* American Journal of Public Health, *October 1977, p. 946 and p. 954.*

Figure 2. Mean Change in Symptoms Index (in millimeters of mercury)



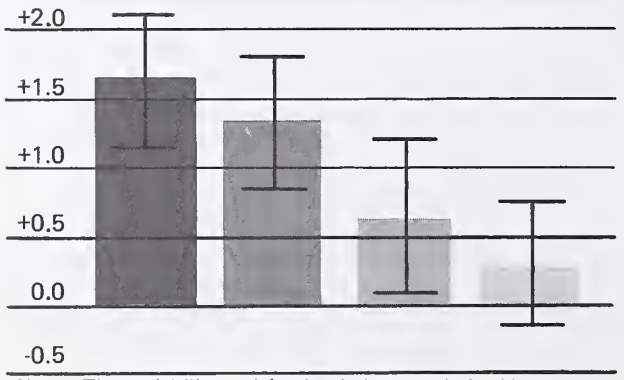
Note: The symptoms index was derived by summing the frequency ratings of 51 symptoms on a four-point scale going from "no occurrence of symptoms" to "occurrence all the time."

Figure 3. Mean Change in Performance Index



Note: The performance index was derived by summing self-ratings on four types of performance. The items were rated on a six-point scale going from "poor" to "excellent."

Figure 4. Mean Change in Sociability - Satisfaction Index



Note: The sociability-satisfaction index was derived by summing six items rated on a five-point scale going from "poorly" to "better than ever."

in Groups A and B to use during working hours. The 15-minute relaxation periods could be taken either at home or at work, but those taken in the work setting were taken on the employees' own time, such as during coffee breaks, lunchtime, or before and after regular working hours.

The blood pressure measurements were obtained during periods of the day when the subjects were not taking the relaxation breaks. The questionnaires filled out by the volunteers during the 12-week investigation were designed to measure the employees' own perceptions of their general health, overall performance, and sense of well-being.

General health was measured by a *symptoms index*. It indicated how often during the three-month study the participants reported experiencing a wide variety of specific symptoms of illness or anxiety. Symptoms included headache, backache, nausea, diarrhea, difficulty in falling asleep and nervous habits.

Performance was also assessed, yielding a *performance index*. This was composed of the volunteers' daily rating of their own physical energy, their strength of concentration, their ability to handle problems, and their overall efficiency according to four six-point scales.

The sense of well-being was evaluated on two questionnaires. A *sociability-satisfaction questionnaire* was administered biweekly and consisted of the following questions: "During the past two weeks, how have things been going for you (a) at home or with roommates, (b) with close friends, (c) with people at work, (d) in your satisfaction with your work, (e) in your confidence in yourself, and (f) in your satisfaction with yourself?" A *happiness-unhappiness questionnaire* was also administered biweekly and asked how often each of nine moods was experienced. These moods, which encompassed both "happy" and "unhappy" states, were rated on a four-point frequency scale.

Significant Results

Overall, the four groups' cooperation with the program was excellent. On their daily records, Group A reported eliciting the relaxation response an average of 8.5 times per week throughout the eight-week experimental period. Group B reported "simply relaxing" an average of 8.8 times per week. Only 30 percent of Group A and 19 percent of Group B averaged less than 7 practice sessions per week, and 52 percent of Group A and 58 percent of Group B averaged 10 or more sessions per week.

Significant decreases in blood pressure occurred only in Group A (see Figure 1 on page 23). Virtually no changes in blood pressure occurred in Groups C or D.

In Group A, between the first session and the last, there was an average decrease of 12 millimeters of mercury (mm Hg) in systolic blood pressure (the pressure of the blood on the walls of the arteries when the heart muscle contracts). In Group B systolic blood pressure decreased an average of 6.5 mm Hg, and in Group C it remained essentially unchanged.

Similar changes occurred in diastolic blood pressure (the pressure of the blood on the walls of the arteries when the heart muscle relaxes). Between the first session and the last, diastolic blood pressure decreased 7.9 mm Hg in Group A but only 3.1 mm Hg in Group B and 0.3 mm Hg in Group C.

This pattern of blood pressure changes among the three groups appeared in both sexes, at all ages, and at all levels of initial blood pressure. However, in all three groups, but especially in Group A, greater decreases in both systolic and diastolic blood pressures tended to occur in individuals with higher initial blood pressures.

The same pattern of changes was noted on the indexes of general health, performance, and sense of well-being, as shown in Figures 2, 3, and 4. After the eight-week experimental period, the greatest average improvements on each of these indexes occurred in Group A. Group C was least improved, and Group B was intermediate. These improvements were statistically significant on three of the four indexes—those for symptoms, performance, and sociability-satisfaction. The changes on the happiness-unhappiness index were not statistically significant.

Deciding on a Remedy

In this investigation at Converse, all participants in Group A were asked to elicit the relaxation response twice a day. However, analysis of the self-reported practice patterns suggested that bringing forth the relaxation response once a day may have been sufficient to obtain the beneficial effects.

A seven-month investigation is underway at PPG Industries to ascertain the optimal frequency of relaxation response breaks necessary to obtain beneficial effects. This investigation, supervised by PPG's medical director, Dr. Lee B. Grant, involves approximately 300 management-level employees from all divisions of PPG's home office in Pittsburgh and will be completed in 1978.

The results of the Converse investigation indicate that relaxation response breaks not only are feasible in the workday world but also are associated with improvements in general health, performance, and well-being and with a lowering of blood pressure.

Such a decrease is desirable even in an individual whose blood pressure falls within the normal range, for the risk of developing heart attacks and strokes (the causes of over 50 percent of the deaths in the United States today) is directly proportional to the level of blood pressure. As blood pressure goes down, the risk diminishes.[4]

This lowered risk can be translated into dollars saved. It has been estimated that the cost of cardiovascular disease in the United States today is $26.7 billion per year.[5] Although it is much more difficult to quantify the costs of other stress-related disorders, such as anxiety, the presence and deleterious effects of these impairments are widely recognized.

Relaxation response breaks appear to alleviate stress-related problems. Both individuals and industries should benefit from incorporating this relatively inexpensive and safe "health habit" into the work environment.

DMJ

Instructions to Elicit the Relaxation Response

1. Sit quietly in a comfortable position.
2. Close your eyes.
3. Beginning at your feet and progressing up to your face, deeply relax all your muscles. Keep them relaxed.
4. Breathe through your nose. Become aware of your breathing. As you breathe out, say the word one silently to yourself. Continue the pattern: breathe in . . . out, "one", in . . . out, "one"; and so on. Breathe easily and naturally.
5. Continue for 10 to 20 minutes. You may open your eyes to check the time, but do not use an alarm. When you finish, sit quietly for several minutes, first with your eyes closed and later with your eyes opened. Do not stand up for a few minutes.
6. Do not worry about whether you are successful in achieving a deep level of relaxation. Maintain a passive attitude and permit relaxation to occur at its own pace. When distracting thoughts occur, try to ignore them by not dwelling on them and return to repeating one. With practice, the response should come with little effort. Practice the technique once or twice daily but not within two hours after any meal, since the digestive processes seem to interfere with eliciting the relaxation response.

[4] *United States Department of Health, Education, and Welfare, Vital and Health Statistics, "Mortal Trends for Leading Causes of Death," DHEW Publication No. [HRA] 74-1853, Series 20, No. 16 (Washington, D.C.: U.S. Government Printing Office, 1974); Herbert Benson, "Systemic Hypertension and the Relaxation Response,"* The New England Journal of Medicine, *May 1977, p. 1152; and Edward D. Freis, "Hypertension and Atherosclerosis,"* American Journal of Medicine, *May 1969, p. 735.*

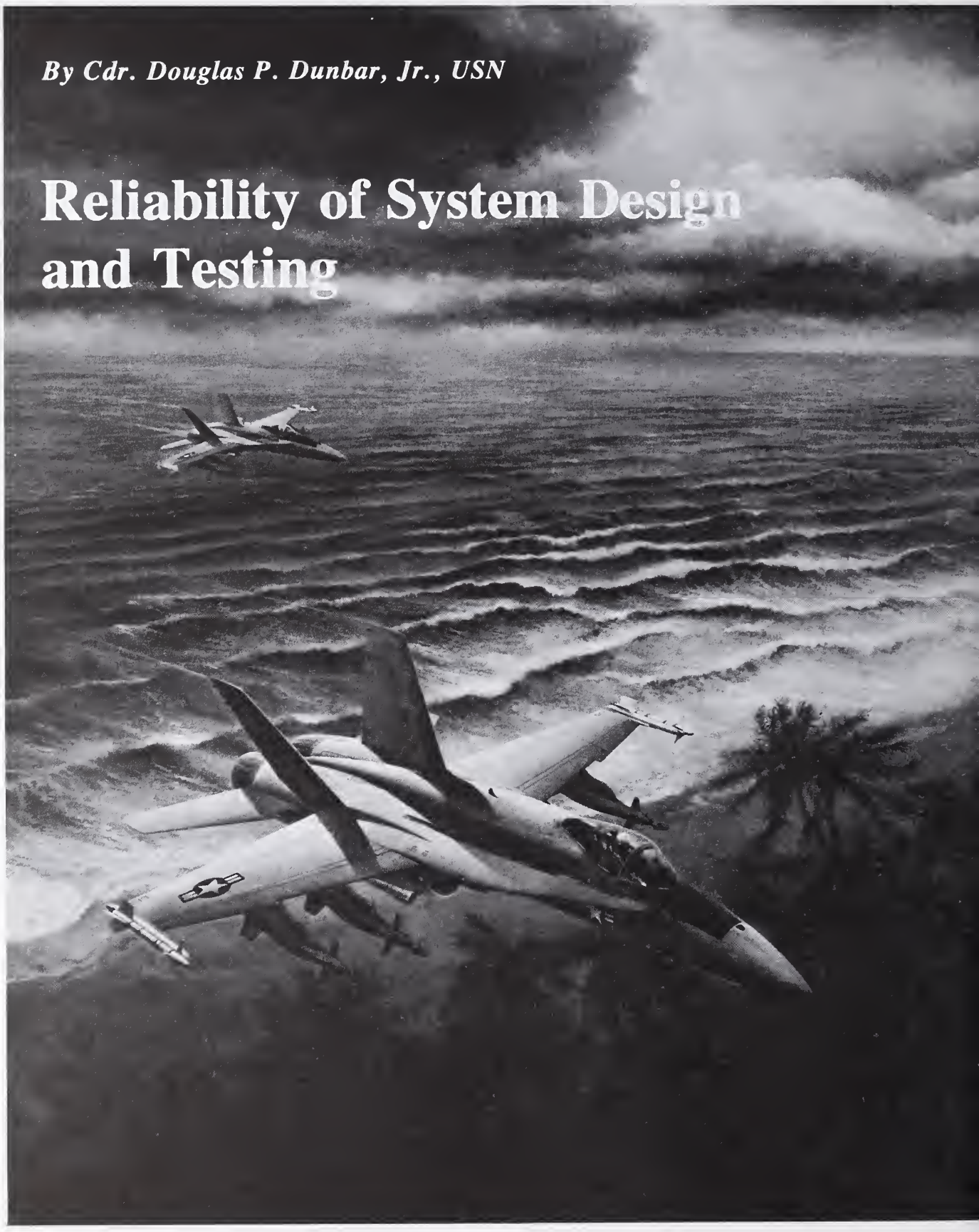
[5] *American Heart Association,* Heart Facts (*Dallas: National Center of the American Heart Association, 1976).*

RUANNE K. PETERS is a postdoctoral research fellow at the Channing Laboratory, Harvard Medical School in Boston, Massachusetts.

DR. HERBERT BENSON is an associate professor of medicine at the Harvard Medical School. He is also director of the Hypertension and Behavioral Medicine Sections of Beth Israel Hospital in Boston, Massachusetts.

By Cdr. Douglas P. Dunbar, Jr., USN

Reliability of System Design and Testing



With shortfalls in reliability driving up support costs, the Navy has come to believe that an ounce of prevention during design and testing is worth a pound of cure after deployment.

For many years, the Navy has been challenged with developing reliable weapon systems and equipment. Shortfalls in reliability can severely degrade combat effectiveness and increase support costs. Although weapon systems readiness is a foremost concern of commanders, increases in ownership costs and logistics support requirements continue to outpace the Navy's budgetary and operational capacity to meet such demands.[1]

To counter this trend, the Navy must emphasize and increase the reliability of new weapon systems. Reliability begins on the drawing board and must be assessed throughout development. Even though this concept has long been embraced by military standards and specifications, the fact remains that substantive improvements in the reliability of fleet systems have not been realized to the degree desired. Newly developed systems and equipment often meet reliability standards in the laboratory, but fail to perform well in the fleet environment.[2]

Traditionally, design and demonstration tests have been structured around specifications that may have been written with little regard to the environment in which the system will be operating. Certainly, one of the first steps in the system acquisition process should be determining the environmental conditions under which the system will operate. This is being done in the development of the F-18 Naval Strike Fighter. In the F-18 development program, the expected operational mission environment is a primary determinant of design and test requirements. The Navy and contractors have quickly come to realize that OME considerations during development lead to improved system reliability and reduced life-cycle costs.

Reliability by Design

Existing design and test requirements often inadequately represent the operating stresses imposed on fleet aircraft and equipment. As a result, failure modes not considered or discovered during design and testing may surface after deployment with dismaying regularity. Significant improvement of F-18 reliability is one of the highest program objectives. Even as early as the design stage, reliability is as important a consideration as system cost and capability. As such, the Naval Air Systems Command has developed a management approach to ensure the acquisition of effective and reliable systems that minimize life-cycle costs.

The OME testing includes all exercises and conditions that the airplane and its subsystems will be subjected to during their operational lifetime. This includes training and combat missions, critical flight conditions as outlined in the F-18 flight envelope, excursions beyond normal performance limits of the airplane and pilot, and ground handling and storage. Test criteria for such factors as payload capacity, vibration, temperature, altitude, humidity, and acoustics are predicated on the operational mission environment. Additionally, design attributes necessitated by the OME now become design-to requirements for all systems under development. These design-to requirements are prescribed in the Navy prime specifications and are passed along from the contractor to subcontractors through equipment procurement specifications. Thus, equipment is designed and tested under conditions that approximate the expected operational environment.

F-18 Mission Profiles

A mission profile is a detailed technical description of a deployed system's expected use. The information is indispensable to the satisfactory design and testing of the system at the contractor's plant. It provides the baseline against which system reliability and performance can be measured. Military procurement specifications rarely include an adequate mission profile, and contractors are seldom required to develop one. This deficiency is due to the absence of military standard methodology for mission profile development and use.[3] This omission results in serious reliability shortfalls when the system begins to experience actual conditions.

Because a key factor in the success of the F-18 is achieving a level of reliability much higher than that of current aircraft, emphasis was placed on realistic operational mission profiles. These profiles define the environment in which the system is designed, tested, and expected to perform.

Defining the mission of the F-18

---

[1] *W.J. Willoughby, "Reliability by Design, Not by Chance,"* Defense Management Journal, *April 1976, pp. 12–18.*

[2] *Lt. Gen R.T. Marsh, USAF, "Avionics Equipment Reliability: An Elusive Objective,"* DMJ, *April 1976, pp. 24–29.*

[3] *Naval Electronics Systems Command,* Generation of a Guideline for a Standard Mission, Profile, *TR 958–6145–1005, August 20, 1976.*

was the first step. Typical missions for the fighter and attack roles of the airplane include:

- Fighter escort.
- Barrier combat air patrol.
- Deck launch intercept.
- Air combat training.
- Interdiction.
- Close air support.
- Low-level navigation or strike.
- Carrier qualifications.
- Surface and subsurface search.
- Ferry.
- Familiarization or instrument training.

Critical combat missions were based on the operational requirement. Training missions were developed from squadron surveys, training requirements for similar aircraft, and pilot experience data. A frequency of occurrence for each mission was established, as were combat-training mission ratios. These were based on experience and the intended role of the F-18. Individual missions consist of up to 15 segments (climb, cruise, combat, air refueling, descent, etc.) which constitute the profile. Performance parameters such as altitude, distance, fuel, and time were calculated for each mission segment.

Although the F-18 is expected to spend the majority of its time within the regions defined by the mission profiles, its operations outside the flight envelope were also considered. Critical design points, some of which were not within the composite mission matrix of flight conditions, were selected. Mission segments, flight envelopes, and ground operations together form the F-18 operational mission profile.

F-18 Mission Environment

Although the expected operational environment has many elements, several have been shown to be most responsible for equipment failures. These include:

- Flight loads.
- Vibration, shock, and acoustical noise.
- Temperature, altitude, and humidity.
- Salt, sand, and dust.

Studies indicate that three of these factors—temperature, vibration, and moisture—account for a majority of environmentally induced failures. Accordingly, these factors were stressed in the development of the F-18 OME. Other elements, although having relatively less impact on field failures, are significant and were also considered.

The most dynamic portion of the composite mission is the Air Combat Maneuvering phase of the combat mission segment. ACM takes up 3.34 minutes of the 8.33-minute combat segment, and represents approximately 3 percent of the mission flight time. However, the environmental extremes encountered in this phase are significant. Air combat studies using F-18 and F-15 flight simulators, plus F-4, F-15, and YF-17 flight experiences, were conducted to determine the expected F-18 normal load factor environment. These data indicate that during ACM the airplane will likely be stressed beyond its normal design load factor for a small portion of the time. Approximately 2.5 percent of the F-18 ACM time is expected to be above the 7.5 *g* design limit load factor. Flight loads for other mission segments and critical mission points were similarly derived to establish equipment design criteria.

The thermal environment for aircraft equipment depends on external factors such as ambient temperature, humidity, altitude, and speed of the aircraft, as well as on internal factors such as equipment heat dissipation and aircraft-supplied cooling air. Analysis of external thermal influences on the F-18 equipment environment included:

- Climatology studies of predicted land-based and open-ocean operations areas.
- Temperature distributions at sea level and at various altitudes.
- Mission-segment environment,

and frequency of and time per occurrence.

- Rapid changes in temperature, pressure, and humidity resulting from transient maneuvers.

Internal thermal influences were assessed by dividing the airplane into 11 thermal zones and establishing design requirements for each.

Vibration significantly affects equipment reliability. F-18 vibration-related design criteria were based on vibration measurements taken from other fighters and on the F-18 environment as presented in the mission profiles. Vibration levels were established for equipment located in separate zones of the airplane. Considerations in developing this environment included critical flight exercises such as catapults and arrested landings, high-speed low-altitude flight in turbulent air, gun firing, and normal flight operations.

The F-18 will actually be in flight less than 4 percent of its life.[4] The remainder of the time is spent in storage, handling, and maintenance. The ground environment considerations include seawater spray, stack gas from conventional-powered aircraft carriers, rain, abrasion from nonskid flight deck coverings, humidity, exhaust fumes from other aircraft, electromagnetic interference, airborne contaminants, and temperature. Additionally, operational ground activities such as refueling, arming, inspections, and maintenance are considered in the design requirements for equipment.

Integrated Test Program

The F-18 test program calls for a logical sequence of testing at increasing levels of assembly and environmental complexity. Test feedback is applied in subsequent design efforts to produce high reliability equipment. Testing is divided into three major categories—development, demonstration, and acceptance. The development phase assesses the design's suitability for mission-critical environments. It includes a reliability growth program known as test, analyze, and fix, and utilizes closed-loop failure reporting. The demonstration phase verifies design requirements during laboratory and actual flight conditions. Included in this program are 50 dedicated reliability demonstration flights. During the acceptance phase, tests are conducted to verify that the equipment adheres to the agreed-upon specifications.

In the accelerated testing approach, the system, in short-term simulated tests, is subjected to the wear and tear it is expected to endure in the course of its operational lifetime. Testing should be designed to induce failures. Combined temperature, vibration, and humidity environmental cycling will be conducted on several mission-critical systems such as the radar.

Contract Requirements

The F-18 prime contract and the engine development contract contain reliability and maintainability guarantees. Contractors have set reliability and maintainability design goals which exceed their contract guarantees and which are steadfastly pursued during subsystem and component development. As the design develops, predictions of equipment reliability are compared with the allocation to determine acceptability.

At key decision points during the full-scale development phase, the contractor is required to demonstrate reliability growth consistent with the guarantees. At 1,200 cumulative flight hours, a period which corresponds to the low-rate production decision approximately 18 months after first flight, the system mean-flight-hours-between-failures must be 2.9 hours or greater. At 2,500 flight hours, a period which corresponds to the full-production decision approximately 29 months after first flight, the system MFHBF must equal or exceed 3.7 hours. At maturity, the F-18 design MFHBF may exceed 4 hours.

Reliability, maintainability, program management, and other life-cycle cost factors have been incentivized in the F-18 contract through an award payment plan. The contractor's ability to earn award payments is based on his achieving and improving reliability and maintainability factors. The total fee available under the award payment plan is $39 million, $24 million of which is directly related to meeting reliability and maintainability requirements.

Total-Cost Implications

The life-cycle cost of a system is the total cost of acquisition and ownership of that system over its full life. The two primary factors included in LCC are development and acquisition costs and operating and support costs. Estimates of typical O&S costs for weapon systems range from 50 to 75 percent of the LCC. The growing cost of major weapon systems, coupled with a relatively fixed defense budget, has forced the Department of Defense to carefully consider extended costs of acquiring a new system. The Navy recognizes that a decision to acquire a new system is also a decision to provide support for that system once it is in the fleet. Because O&S requirements are driven by the design of system equipment, it is critical that LCC be considered early in development. It is extremely difficult and costly to reduce O&S costs once the system is deployed.

DoD Instruction 5000.28 establishes cost as a parameter equal in importance to technical requirements. Effective control of system expenditures can be achieved by practical trade-offs between operational capability, schedule, and costs. Because of the ability to estimate production costs more accurately and the supportive production-cost data base available, initial goals for design-to-cost are usually established in the form of average unit-flyaway cost.

Programs to strengthen the data base of O&S costs have improved greatly in the last few years and "design to" goals have been extended to this area. Program managers are strongly encouraged to use life-cycle cost estimates as a basis for cost trade-off analyses when considering development versus operating and support costs.

The major design characteristics which drive O&S costs are reliability and maintainability. Reliability and maintainability in turn drive the manpower requirements in the operation and support of systems. Manpower has become the most expensive element in the DoD budget, and is reflected not

[4] *McDonnell Aircraft Company,* F-18 Mission and Operational Environment, *MDCA 4239, June 30, 1976 (classified).*

only in the number of people required to operate and support a system, but in the cost of training them.

The Navy has carefully predicted and analyzed F-18 O&S costs early in the development phase. This should reduce total LCC and help alleviate crowded working and living conditions aboard aircraft carriers.

A major factor in reducing operating and support costs is improved reliability of F-18 ancillary equipment. As noted earlier, a key element in achieving increased reliability is the use of the expected operational mission environment as the basis for design and test requirements. The additional cost of operational mission environment design and test was borne by the F-18 program office. It should be noted, however, that only mission-critical F-18 terms were evaluated for specific OME application. Most of the remaining F-18 equipment, 273 procured items out of a total of 316 procurements, are simple designs (valves, switches, etc.) and were already being procured under specifications having design and test requirements closely matching the operational mission environment. In effect, almost 94 percent of the F-18 contractor-furnished equipment will be procured with specific OME design and test criteria, or under existing specifications closely matching the OME intent. Under separate contract, the government-furnished engines are also being designed and tested to the OME. To date, the Navy has selected 19 contractor-furnished items for OME major equipment design and test requirements. The equipment selected includes:

- Radar set.
- Flight control electronics set.
- Inertial navigation system.
- Multipurpose display.
- Air-conditioning system.
- Auxiliary power unit.
- Airplane-mounted accessory drive.
- Pilot's heads-up display.
- Motive flow fuel pump.
- Hydraulic reservoir assembly.
- Maintenance monitor panel.
- Air turbine starter.
- Air turbine starter control valve.
- Up-front control unit.
- Communication system control.
- Pressure regulator and shutoff bleed valve.
- VER-2 bomb rack.
- Super 14-30 bomb rack.
- AIM-7F launcher.

The total added cost to the Navy of OME design and test of these items is approximately $3.6 million; the expected life-cycle cost savings is estimated to be $108 million — a 30:1 payback. The life-cycle cost savings are significant and demonstrate the effectiveness of the Naval Air Systems Command's new approach to management of material acquisition programs.

More Realism Needed

The operational reliability of many weapon systems in the fleet is far below that which was specified in requirement documents, or demonstrated during development testing. Long-standing design and test requirements and philosophies have not succeeded in providing needed levels of operational readiness or in constraining life-cycle cost growth. The trend toward decreased combat effectiveness and increased support costs must be reversed. The F-18 program is utilizing realistic mission profiles to accurately simulate the expected operational environment of the airplane.

More realistic design and test efforts should significantly improve F-18 fleet reliability and reduce operating and support costs in the years ahead. The F-18 program's application of the operational mission environment concept early in the design phase appears to be a very sound and innovative approach — one with great potential for increasing system operational effectiveness. DMJ

COMMANDER DOUGLAS P. DUNBAR, JR., USN, is the F-18 Assistant Program Manager for Material Acquisition at the Naval Air Systems Command, Washington, DC.

---

*By Michael L. Johnson and Kenneth McCloskey**

The Red River Army Depot's new selection procedure includes an actual performance demonstration by the candidate, an oral evaluation, and a candidate self-assessment.

A New Approach For Identifying Best-Qualified Candidates

Since the enactment of the Federal Merit Promotion Policy in 1959, Government agencies have been challenged to select and promote the best-qualified employee.[1] This precept seems simple enough, but there remains the problem of accurately and fairly measuring each candidate's merit. The problem is not in the failure to select the best-qualified candidate, but rather in the failure to determine who the best-qualified candidate is. Despite the mindful and deliberate steps of the traditional selection process, there is little assurance that the most skilled and knowledgeable candidate will emerge at the top of the list. Indeed, the need for a sound procedure for measuring merit has been evidenced repeatedly in the work force, the agency appeal channels, and the courts.[2]

The Army Depot at Red River, Texas, acting on the belief that fair and unbiased employee selection is critical to its mission accomplishment, recently adopted a new procedure for measuring employee merit. It is called Ability, Skill, and Knowledge Merit Evaluation or ASK ME. To date, ASK ME has been used to assess 1,200 candidates at Red River for selection and promotion actions, and not a single grievance or complaint has been filed.

The ASK ME procedure consists of four phases: job analysis, examination plan, candidate evaluation, and validation.

First, subject-matter experts perform a detailed job analysis, describing the knowledge, skills, and abilities required for a particular job. After an examination plan is developed, an applicant's competitive standing is determined by such methods as performance

*This article is adapted from an award-winning essay presented by the authors at the Army Personnel Alumni Association Professional Development Seminar, held earlier this year in Washington, DC.

[1] *U.S. Civil Service Commission Federal Personnel Manual, "Federal Merit Promotion Policy," Chapter 335, 1959.*

[2] *The Law,"* Time, *October 1977.*

evaluation, oral interviews, and assessment of educational background.

Job Analysis

The steps involved in applying ASK ME can be illustrated by tracing how a mechanic's job was filled. The first step was identifying the subject-matter experts to sit on the job-analysis panel and perform a detailed job analysis, describing the knowledge, skills, and abilities required for the job. Six experts were named, two of whom were supervisors, two were union leaders, and two were journeyman mechanics. (In most instances, the panels will include at least one female, one minority-group member, and one union representative.) Panel members were selected on the basis of their technical skills and objectivity.

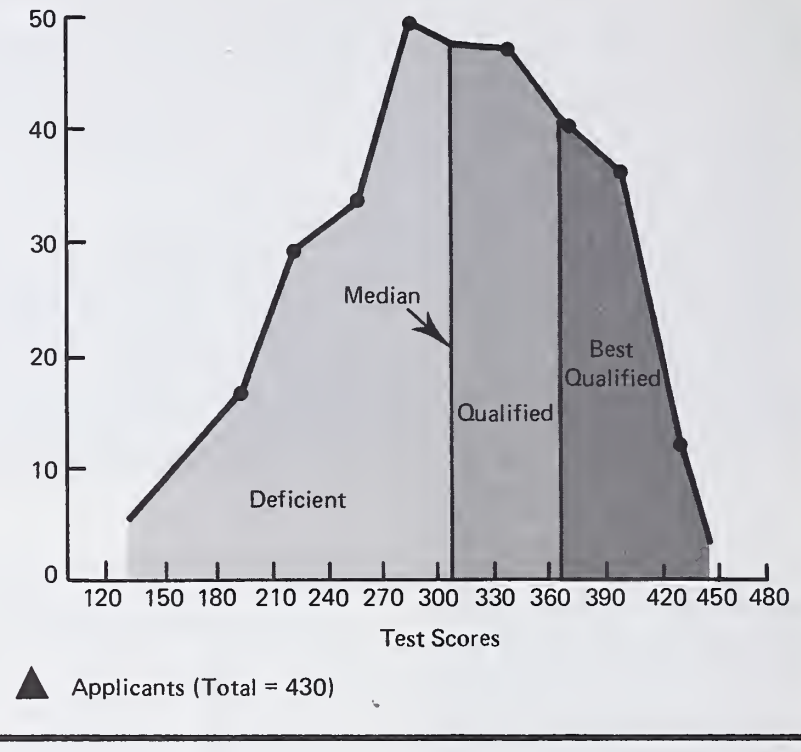
In the initial meeting, a personnel technician explained the purpose of the job analysis and ensured a common understanding of the terminology to be used. Next, the subject-matter experts listed the job elements or tasks that comprise the job. In this case, there were approximately 180. The experts then rated the relative importance of each element, using a form devised by Ernest S. Primoff[3] of the Civil Service Commission. The rating sheets were evaluated by a computer program developed by the Civil Service Commission and modified for Red River's needs. The printout identified redundant items, areas requiring specific training, and the characteristics of the ideal worker for such a position.

Examination Plan

The next step was devising an examination plan to measure ability in each element. The subject-matter experts selected the appropriate measuring device for each element. These devices included performance evaluation; oral evaluation; education, training, and awards; and the personal qualifications statement (including self-ratings).

In the example of the mechanic, the element, "ability to use a micrometer," would obviously be best measured by the performance evaluation method. This illustrates the particular strength of ASK ME. Until now, an applicant's ability to use a micrometer was judged solely on a supervisory appraisal, the accuracy of which was uncertain. For example, a supervisor might unfairly say that an employee is "poor in using a micrometer." Conversely, the supervisor might fall prey to the halo syndrome, and inflate the rating. On the other hand, when the employee rates his own skills, there's really no way to know if he is being candid. In other words, these methods are subjective. With ASK ME, though, the employee actually exhibits his skills. Personnel technicians are not always knowledgeable about how to perform specific job functions so subject-matter experts do the actual scoring on performance and oral evaluations.

Figure 1. Candidate Test Scores



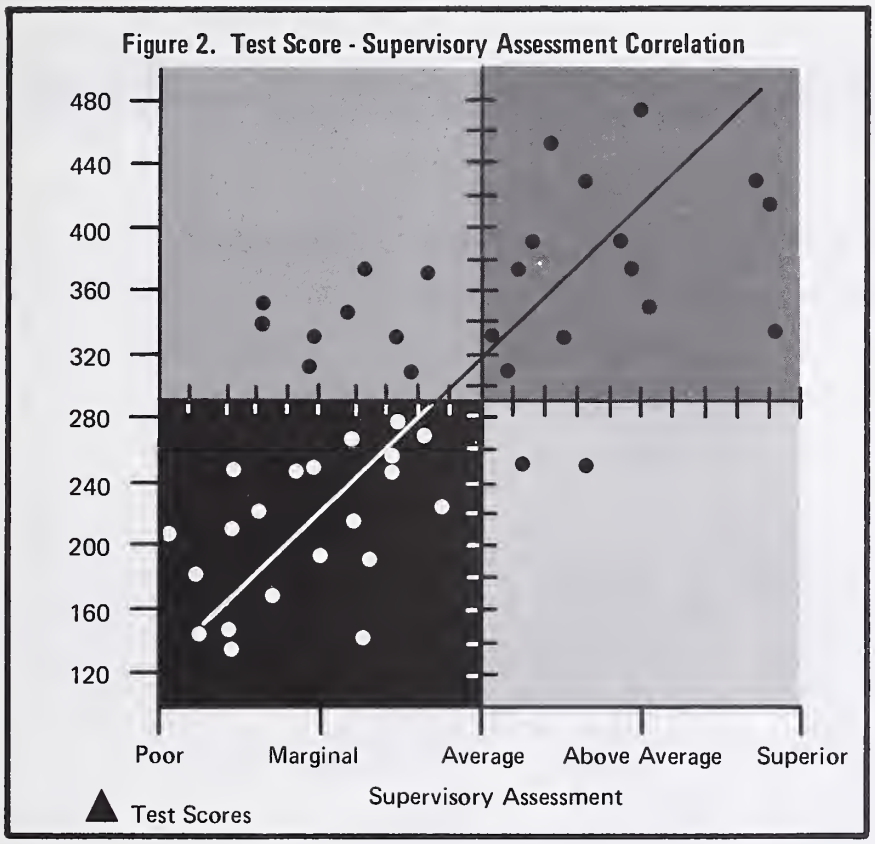
Candidate Evaluation

Here, the actual assessment of the candidates begins. In the case of the mechanic, all of the evaluation devices are used. First, applicants for the position rate their own proficiency at certain elements. The ratings range from "A," meaning the applicant had little or no knowledge of the element, to "E," meaning the applicant considered himself an expert. In many instances, the results of this self-evaluation differed considerably from those of the oral and performance evaluations.

Skills in certain job elements are best measured by oral evaluation. Three technically qualified raters asked each applicant 35 questions. All questions were accompanied by slides in order to reduce possibility of cultural or ethnic bias. Consideration has been given to playing the questions on a tape recorder to ensure that each candidate receives the same instructions.

Journeyman mechanics performed dry runs, and mean times for successful completion of performance tasks were calculated. From this fair and accurate time limits for applicants were determined. Applicants were required

[3] *E.S. Primoff*, "How to Prepare and Conduct Job-Element Examinations, *U.S. Civil Service Commission, Washington, DC, 1973.*



to perform such functions as selecting correct bearings, installing bearings in a crankshaft, and torquing cap bolts. Some applicants installed the crankshaft backwards and others tried to measure bearings with a ruler. Raters could indeed see if a person truly possessed mechanical aptitude.

Based on the data and scores of some 430 applicants, the panel determined qualification categories. The scores ranged from 126 points to 461 points. Applicants scoring 312 or higher were considered qualified. A distribution of candidate selection test scores is provided in Figure 1.

Because the whole procedure clearly delineates the necessary skills, an applicant can easily see what area he needs training in. ASK ME revealed that management was deficient in providing training in trades and crafts. Arrangements were made with the local community college to provide after-duty, vocational training. Areas of instruction included internal combustion, electrical systems, blueprint reading, welding, and fuel systems. Because it utilized depot facilities, tools, and equipment, this training was offered at a reduced cost to employees.

Validation

ASK ME boasts built-in content validity, because only those elements that job-knowledge experts consider essential are used as test items. Content validity is further ensured by the use of all, not just a representative number, of essential elements.

Another validation technique employed was that of predictive validity. Predictive validity is determined by evaluating a selectee's job performance after his first 6 or 12 months on the job and comparing those scores with the scores he made on tests given as part of the selection process. The extent of the correlation, referred to as a validity coefficient, is a direct indication of the predictive strength.

What is a sufficient validity coefficient? Robert N. McMurry in *Tested Techniques of Personnel Selection* states:

> . . .If the correlation between the test scores and criteria of job success is high (at least .50) the test is said to be "valid," and can be used with confidence in predicting the success of applicants.[4]

In our example, a sample of 211 applicant scores and supervisory ratings was used for validation. The validity coefficient of 0.625 was considered adequate for prediction. Simply stated, supervisory evaluations tend to confirm predictions made on the basis of selection test scores (see Figure 2).

Advantages

ASK ME has some obvious strengths. It offers a fair and objective method for identifying skilled employees and is adaptable to almost any position.

As a result of ASK ME, supervisors have become more aware of their responsibility for ensuring that each employee performs all the elements of the job to which he is assigned, and employees have become more aware of the advancement opportunities provided by self-development programs.

Perhaps the most marked feature of ASK ME is that it is the product of collaboration among the work force, the union, and management. Each accepts the system and views it as a fair and objective vehicle for measuring merit.

DMJ

MICHAEL L. JOHNSON is a psychologist in the Organizational Effectiveness Office at Red River Army Depot, Texarkana, Texas. Mr. Johnson is responsible for administering occupational assistance programs, training middle managers, and offering psychometric statistical guidance in various areas.

KENNETH R. McCLOSKEY is Chief of Recruitment and Placement at Red River Army Depot, Texarkana, Texas. He is responsible for the development and implementation of the merit promotion program.

---

[4] *R.N. McMurry,* Tested Techniques of Personnel Selection, *Darnell Corporation, Chicago, IL, 1973.*

Refurbishing the Army's Real

By Brigadier General Donald G. Weinert, USA (Ret.)

Property Management System

The findings presented in a recently completed Army study are shaping the mold from which a modernized real property management structure may soon be cast.

The operations and maintenance of real property is one of the Army's most pressing management challenges. Presently, there are more than 300 Army installations and 1,000 Army Reserve facilities worldwide. Their total replacement value is roughly $80 billion. The money spent on their operations and maintenance and on new construction represents nearly 12 percent of the Army's annual dollar outlay. Certainly, the efficient operations and maintenance of the Army's real property is a management area deserving of the renewed attention it is getting.

It is no secret that the operations and maintenance workload at Army installations is outpacing available manpower and money needed to meet it. A major challenge, then, is getting maximum productivity from each available resource.

In 1968, then Lieutenant General L.J. Lincoln analyzed Army installation operations and maintenance activities. His recommendations led to a more streamlined real property management structure. Now, Lieutenant General J.W. Morris, Chief of Engineers, wants to further improve real property management over the next ten years. He recently sponsored a Department of the Army study designed to determine the effectiveness of ongoing practices and to find ways to stretch the O&M dollar, expand the installation commander's control of O&M activities, and strengthen the relationship between the command structure and the technical management structure so as to improve engineering support. The study also examined real property management systems used by the other services, Government agencies, and industry. The strengths of these systems were identified for possible adoption by the Army.

In evaluating the Army's real property management program, the study group visited 14 installations and the headquarters of the Army's six major commands. Members of the study group repeatedly witnessed how the sophistication of new facilities generates added O&M requirements at a time when resources are getting scarcer. Other increases in workload requirements were seen as stemming from having to comply with energy conservation policies, environmental legislation, and Occupational Safety and Health Act provisions.

The gathered information was evaluated by an interdisciplinary group which included former facilities engineers, a former executive officer of the Office of the Secretary of Defense, a comptroller, and research analysts. Descriptions of the various real property management systems used by the Army's major commands were bound into a reference compendium.

Among the positive features common to most of the installations studied were:

- Increased use of modernized equipment.
- Aggressive programs to reduce maintenance backlog.
- Imaginative customer relations.
- Highly capable personnel in real property maintenance disciplines.
- High personnel morale.

Among the negative features were:

- Excessive paperwork for maintenance actions.
- Inadequate monitoring of contracted work.
- Aged work force.
- Frequent repairs on newly constructed facilities.
- Inordinate time lags in personnel recruitment.
- Limited authority to buy supplies and contract out.

Study findings revealed the growing complexity of operations and maintenance management at the installation level. They also highlighted the role of the facilities engineer who not only orchestrates an installation's O&M actions, but also plans and initiates construction of new facilities and the disposal of unneeded ones. As such, his responsibilities encompass all aspects of real property management, not just the maintenance of it. He is the major figure in the Army's real property management structure (see Figure 1). Collectively, the facilities engineer's responsibilities are referred to as real property maintenance activities (RPMA), even though these activities include such quasi-maintenance areas as firefighting operations, sanitation services, and pest control.

The study group issued 163 recommendations whose implementation will be spearheaded by the Directorate of Military Programs in the Office, Chief of Engineers.

REAL PROPERTY MANAGEMENT

Although some recommendations received consensus approval, such as the one calling for a reduction in the amount of paperwork a facilities engineer must complete, others generated considerable debate. One of the conroversial proposals addressed the current practice of burying RPMA resource requirements in an amorphous block of requirements labeled base operations. The study recommendation calls for a separate administrative program for real property maintenance activities to be a part of the Army appropriation for operations and maintenance. This proposal could well be a precursor to the earmarking of RPMA dollars in all appropriations. Coinciding with this recommendation, the Office of the Secretary of Defense has announced that it will soon direct all services to use separate Five-Year Defense Plan program elements for RPMA.

Another recommendation stirring debate calls for the immediate use of minicomputers by facilities engineers. The study group contends that the computers will substantially enhance real property management. However, there is approval pending on a policy draft which, if adopted, would require all new hardware and software to be standardized so as to be compatible with future Army-wide automated data processing systems. For now, this stands in the way of rapid adoption of the minicomputer proposal.

In a move to promote responsiveness and efficiency, the study group recommended giving maximum Contracting Officer Representative authority to installation facilities engineers. This authority, primarily for the purchase of supplies and minor services, is to be delegated through the installation procurement office. Some installation procurement offices have a standing practice of issuing $1,500 blanket purchase agreement authority to the facilities engineer, while others require him to process requisitions for every action. It is believed that the latter offices would delegate this authority with great reluctance, and the Deputy Chief of Staff for Logistics may well have to sort out the pros and cons of this recommendation.

Proposals were made concerning consolidations and inter-service support agreements. A consolidation occurs when real property management functions of one or more services are combined within a geographic region. This is currently practiced in Hawaii by the Army and Air Force. Inter-service support agreements, on the other hand, are contractual arrangements for one service to supplement its own resources with the resources of another service. The study group's proposal outlines a policy directing installations to periodically evaluate the economic and operational feasibility of consolidations and inter-service agreements, and to initiate them where justified. The study group recommended that a regulation establishing guidance for these actions be published by September 1979.

Study findings emphasized that operations and maintenance costs of a facility or structure exceed the cost of construction. One proposal to help hold down O&M costs is to move away from the walk-away construction contracts, and replace them with contracts requiring the builder to operate the facility for a specified shakedown period. Another proposal, intended to promote greater emphasis on O&M considerations during design, gives the users and those with O&M responsibilities a greater role in design.

The expanded design role for the facilities engineer and his personnel is part of a total package to make better use of practical experience. His role would be further expanded by converting some of the 50,000 O&M craftsman positions into managerial positions. This requires a dedicated response from civilian personnel classifiers. Proposals related to this issue have already stimulated dialogue focusing on the key role personnel officers will have to play if these proposals are to be implemented. Indeed, the cooperation of civilian personnel offices will be one of the most important factors in upgrading the real property management capability at installations. New staffing guidelines, coupled with representative job descriptions for key positions, are expected to give local personnel offices the necessary latitude to carry out their part of the strategy. The creation of new managerial positions should give the facilities engineer a better resource management capability to plan, program, supervise, and inspect. He can devote staff energies to supervising contract performance and thus use contract resources to a greater extent.

Some Department of the Army officials contend that although facilities engineers seem well aware of managerial staff shortfalls, they continue to use manpower authorizations to fill craftsman positions at the expense of management positions. It is believed that this perpetuates a reluctance to use contract resources because the facili-

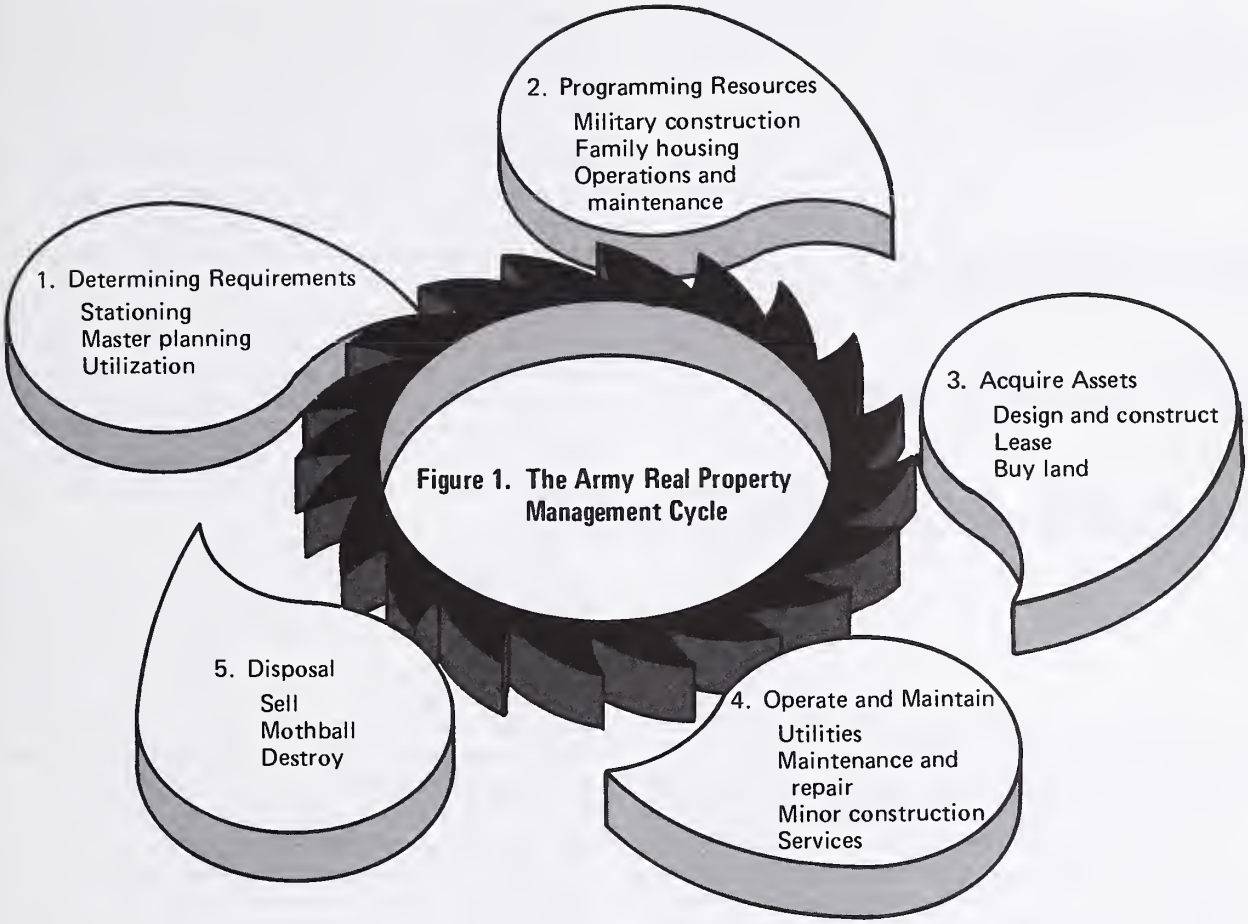


Figure 1. The Army Real Property Management Cycle

ties engineer is left without an adequate staff to assess the contractor capabilities, specify contractor performance levels, and inspect contractor work.

To remedy this staff deficiency, it is recommended that there be specified authorizations for management positions. Action has already been taken on a proposal to specify functions that will not be performed in-house without a supportive and auditable cost analysis and major command approval. Cost effectiveness of contract work will be determined on a case-by-case basis within guidelines established by the Office of Management and Budget.

There is reason to believe that more contracting is needed. The need is evidenced by the backlog of maintenance and repair, currently estimated at more than one billion dollars. There is no indication that the backlog has affected the Army's principal mission, but the backlog and the increasing workload portend serious trouble should nothing be done to alleviate the situation.

The contract option did generate controversial discussion. Some study group members argued that the installation commander would have less control with predominately contract O&M. Others questioned the dependability of contract workers in time of crisis or emergency. In arriving at the recommendation for increased contracting, the study group kept in mind that the expansion of operations and facilities at U.S. bases in peace and war is achieved primarily through contracting. As for the commander's control in emergency situations, facilities engineers at most overseas installations rely on contractor personnel and local nationals. So, by comparison and demonstration, it seems reasonable to believe that stateside contractor personnel can be relied on during crisis.

Though small in-house contingents are required for emergencies, a full conversion to contracting all rather than selected O&M functions is feasible from a managerial standpoint. The extent of the proposed conversion to contracting O&M services should be clearer in July 1979, the target date for publishing new real property management contract plans and policies.

For now, the possibility of creating the position of liaison officer to provide direct support to installation and major command headquarters is being considered. This officer would have a single point contact at installations and would assist in resolving in-house and contract-related engineering problems associated with real property management actions and military construction. While this consideration is being weighed, the Chief of Engineers is moving to have supporting engineer districts provide stronger backup to installations. He will authorize funding

and manpower for the districts to allow them to offer more direct assistance to the facilities engineer.

Among the key proposals being implemented are those involving adjustments in the programming, planning, and budgeting system. Herein lies the path to improved linkages between the command structure and the technical management structure. The facilities engineer has had to draw from the base's annual operating resources in performing current and long-range real property management functions. Command decisions at some installations have not always taken into account long-term RPMA. It is a problem which can be corrected by placing technical management more into the decision-making mainstream and by giving RPMA more visibility in the programming, planning, and budgeting system. This will be accomplished by establishing a separate real property management program element in the Five-Year Defense Plan and a separate program element in the Army appropriation for operations and maintenance. These initiatives will encourage commanders and program directors to give careful consideration to short- and long-term RPMA requirements during planning, programming, and budgeting. The existence of real property management elements in the OMA allows the facilities engineer to establish and better defend a consolidated program that encompasses RPMA, military construction, real estate and family housing.

In further improving the articulation of requirements, many requirements will be categorized as being either base-level or priority-level. The base-level requirements are those necessary to maintain readiness and the quality of life at an installation at an acceptable level. Priority-level requirements are those necessary to meet the major command and Department of Army mission demands. Such categorization should help managers defend budget requests under zero-base budgeting (see Figure 2).

The study group examined the Army Industrial Fund cost accounting and fiscal management as practiced at some U.S. Army Materiel Development and Readiness Command installations. The advantages were often negated by disincentives, sufficient to invite caution in expanding use of industrial funding for RPMA to other major commands. At the industrial installations, for example, commanders are encouraged to produce items or services at the lowest possible cost. This forces them to constrain overhead to the maximum extent possible, and long-range RPMA investments tend to suffer as a result. Though the Army Industrial Fund concept supported competition in industrial operations, its theoretical advantages when applied to other types of real property management were found wanting.

Clearly, this study effort reflects the Army's firm commitment to strengthening its real property management system. Already, a handful of the study group's 163 recommendations has been implemented, and it appears quite certain that adoption of a number of the remaining ones will follow after further evaluation and discussion. Certainly, the groundwork has been laid for improved real property management over the next decade.

DMJ

Figure 2.
Categories of Requirements

Priority Level

- Commander directives
- Standards improvement
- New missions
- Deferrable maintenance and repair backlog

Base Level

- Essential functions for the mission
- Essential functions for quality of life
- Nondeferrable maintenance and repair backlog

BRIGADIER GENERAL DONALD G. WEINERT, USA (Ret.) is now the Executive Director of the National Society of Professional Engineers in Washington DC. In his last Army assignment, he served as special assistant to the Chief of Engineers and headed the study effort on which this article based.

By Ronald D. Daniel

Laying the Groundwork For Retooling The Software Factory

The U.S. Army Computer Systems Command is trying to improve its software reliability by freeing its programmers and analysts from dull, repetitive tasks and allowing them to concentrate on the more intriguing problems of software production.

Faced with rising programmer costs and declining hardware costs, the United States Army computer Systems Command resolved in late 1975 to apply the "software factory" concept to the development, design, and maintenance of management information systems. In effect, the Command decided to use its computer resources to automate the manual tasks associated with developing software, thereby lowering costs by substituting a cheaper resource for a more expensive one. The hope was that software reliability could be improved by freeing programmers and analysts from dull, repetitive tasks and allowing them to concentrate on the more challenging problems of software production.

The project is now at the point where the software tools required to achieve this objective have been determined. The process of identifying these tools yielded some unexpected by-products and a few noteworthy lessons on how to retool a software factory.

Approach

The first step of the project was defining an approach that would best achieve the goal. An examination of similar projects revealed three major factors that had not been addressed:

- Most producers of software al-

ready have a considerable investment in resources and personnel that together form a rudimentary software factory. These tools represent a significant investment and should be incorporated into any plans for a new software factory.

- A project of this nature could continue indefinitely unless the scope is clearly delineated, with technical and cost restraints stated and enforced.
- The rapidly changing technology of computer software tends to overtake such projects, making them obsolete before completion.

In an effort to avoid these problems, an approach of planned retooling was taken. This offered a way to gain maximum use of the existing software base and to keep disruptions of the production environment to a minimum. The scope of the project was limited to the portion of the system life cycle from receipt specifications through systems testing. Only current technology was to be considered, and all processes ancillary to software development were excluded.

The task was divided into two phases: identifying the software tools that comprise a state-of-the-art software factory; and comparing the existing software factory to the state of the art described in the first phase. This approach provided a target within current technology and a means to phase the acquisition and implementation of new software tools.

The Project

Begun in March 1976, the project proceeded as follows:

- Familiarization with the organization and refinement of a study methodology.
- Review of Army and Computer Systems Command literature describing the mission and procedures.
- Formal interviews with managers, programmers, and analysts.
- Collation and evaluation of materials.
- Definition of an optimal software factory.

"Most producers of software already have a considerable investment in resources and personnel that together form a rudimentary software factory. These tools represent a significant investment and should be incorporated into any plans for a new software factory."

"Additionally, tools and component interfacing must receive a great deal of emphasis early in the project. Certainly the long lead time associated with a retooling project makes it imperative that steps be taken to prevent the product from becoming obsolete before it is completed."

It quickly became apparent that the concept for an ideal software factory would be more useful if it were slanted toward the mission of the Computer Systems Command rather than that of some hypothetical software developer. With this change, the project's two phases became blurred. Defining the ideal software factory to accomplish the organization's activities required a description of those activities. Information about the formal system had already been obtained through the literature review, but determination of how the software factory was actually functioning required talking to the people doing the work. It was decided that one interview format would be devised to gather the necessary information.

The interviews were designed to glean information about procedures, existing tools, and areas needing improvement. A list of tools, compiled from earlier projects of this nature, provided consistency to the interviewing and ensured that all phases of the software production process were discussed. The information was then analyzed to determine the ideal software factory for the Computer Systems Command.

Although it is designed to work as an integrated system, this ideal software factory can be broken into three main divisions:

- A control and coordination division to handle such system management tasks as controlling access to facilities, providing a communications network, and gathering and maintaining statistics on usage.
- A design and construction division to provide support for system design, development, and maintenance, and to perform such tasks as the generation and maintenance of control documentation, the verification of structural consistency between levels of requirements and design decomposition, and the monitoring of consistency between code and documentation when changes are implemented.
- A test and evaluation division to edit and format test plans, generate mass data for system testing, and assist in the preparation of special-case test data.

Once the target system was described, a more complete documentation of the existing system was begun. The interview schedule was stepped up, and data being collected were arranged into a suitable form. Each piece of support software (tools and utilities) was described in terms of its function, users, and origin. The tools identified in this way were classed by function and by the phase of the software production process in which they were used. The functions performed by the ideal software factory were then com-

Thirteen Principal Tools for Upgrading the Army's Software Factory

Tool	Function
Integrated Library System	Provides integrated means for storing, retrieving, and manipulating source code, documentation, and design statements.
Metacompiler	Translates COBOL source code into functionally equivalent source code for various computer environments.
Test Data Formatter	Interactively supports the development of special-purpose test data by conversationally eliciting file and element descriptions, control data, etc.
Archiver	Controls the selection and movement of integrated library system data to off-line storage.
Auditor	Supports maintenance of data for a functional configuration audit.
Design Language	Supports system design by providing a disciplined way to communicate system-design specifications.
Requirements Specification Language	Supports via formal language the transmission of system requirements between users and designers.
Data Base Analyzer	Analyzes source code for semantic and syntactical errors not examined by the compiler.
Decision Path Flowcharter	Produces a graphic image of a system's decision linkage.
Conversational Assistance	Provides English-language diagnostics rather than the error numbers now furnished.
Mailbox	Provides for flexible communication between users on the interactive system.
Documentation Analysis Program	Interactively provides standardized formats and monitoring of system documentation.
Test Script Generator	Scans source code and automatically extracts information on operational interface to generate operational test scripts.

pared to those being performed by the present system. Thirteen tools were identified that would upgrade the current software factory to a point consistent with the goal of the project (see figure).

Before tools could be developed or acquired, though, a plan had to be developed to ensure that all of the independently developed pieces of the system would properly interface and work as a unit. The tools were ranked by need within the organization and each was given a functional description. This description included a statement of interfaces and interdependencies, integration implications, and advantages over the existing system. This phase was completed in October 1976.

Analysis of these 13 tools showed that as the mission and organization of the Computer Systems Command evolved, new tools might be required or the desired order of tool acquisition might have to be altered. To address these possibilities, the project plan calls for in-process reviews to reevaluate the need for and the most desirable order of tool acquisition. The plan also addresses the interface between new and existing tools, the identification and location of off-the-shelf tools, the development of complete specifications for tools to be developed in-house, and the introduction of tools to the existing production environment. Under this plan, the need for an abbreviated core dump to reduce machine and programmer time spent in debugging was identified. Because of the simplicity and low cost of such a tool, it was first on the list of tools to be acquired. Specifications were developed, and the tool was acquired and integrated into the system. Acquisition of the more complex tools found on the original list is now under way. These actions are scheduled for completion by December 1979.

By-products

Through interviews with production programmers, analysts, and managers it was discovered that many software capabilities existed within the organization, but were not being exercised. This was attributable to three factors:

- When the need for a capability

existed in a project, a programmer working on that project often would develop a tool to satisfy that need. they were acquired. Often the people using the tool were unaware of its other uses.

"In effect, the Command decided to use its computer resources to automate the manual tasks associated with developing software, thereby lowering costs by substituting a cheaper resource for a more expensive one."

These tools remained exclusively in that project and were never incorporated into the official documentation of the support software base.

- In the past, many software tools that could have been used to perform a variety of functions were being used only for the parochial purpose for which

- In many cases, available tools were not being used because instructions for their use were not accessible, or because the user was unaware of the tools' proper interface with other tools.

The discovery of tool capabilities that were not being exercised increased the potential efficiency of the existing software factory and reduced the need to acquire new software tools. Benefits also resulted when the descriptions of existing software factory components were consolidated into one document, providing an index of software tools that could help production personnel determine the availability of such tools. Previously, a search of internal documentation and vendor manuals was needed to determine what tools were available.

Conclusions

Problems created by nonstandard hardware, operating system differences and multiple programming languages tend to limit the applicability of much of the information gained in the course of this project; however, some conclusions about planning and designing such a project can be drawn.

Any attempt to introduce software factory concepts into an already-functioning shop must include consideration of the base of support for software tools presently in place. These tools represent a significant investment and must be incorporated into any plans for a new software factory.

A project's objective and scope must be clearly stated and the goals pursued with minimal digression.

The in-place software factory is often inadequately documented. Retooling the software factory requires documenting the existing system.

Additionally, tools and component interfacing must receive a great deal of emphasis early in the project. Certainly the long lead time associated with a retooling project makes it imperative that steps be taken to prevent the product from becoming obsolete before it is completed. These steps vary with the nature of the project, but generally include targeting the project at a point just within the state of the art, reviewing organizational plans to ensure a continuing need for the tools, and realizing that the perfect software tool seldom gets past the design stage. DMJ

RONALD D. DANIEL was a Computer Specialist for the Executive Software Requirements and Control Office of the U.S. Army Computer Systems Command, Ft. Belvoir, Virginia, when this article was prepared. He is currently employed in a similar capacity by the Defense Investigative Service in Washington, DC.

One More Time

SIR: *It happens over here too*! As a British reader of *DMJ* who has only just seen the May issue, I should like to add to the correspondence about wenches and winches.

Many years ago, the British Patent Office published an index to its classification system which contained the memorable entry 'screwing wenches.' In this case, of course, the offending term was 'wrench' not 'winch.'

This had one useful effect. It ensured that the Examiners checked the new index carefully in the hope of finding other similar errors. In this they were unsuccessful, but they spotted a number of other errors.

G.W. HART
Defense Research Information Center
Orpington, England

What Price for Quality?

SIR: Mr. Bauder's article, "Quality at What Price" (July 1978 *DMJ*), addresses a question everyone in business and government wrestles with, answering it with varying degrees of success. The DoD difficulty in contracting for quality is not really much different than that of industry's procuring its material from a myriad of suppliers. It's very difficult.

His description of how contractors dealing solely in the commercial marketplace determine quality level is only theoretically accurate. The auto companies try to establish this optimum level. They frequently fail. Millions of cars have been recalled for unintentional serious defects. There is no evidence that anyone can assure continuous, defect-free (complex) products. The dynamics of the industrial process present too many variables for consistent control. More money spent on the problem delivers diminishing returns. Similar variables exist in the Defense Contract Agency quality system that limit *its* total effectiveness.

Mr. Bauder's final paragraph seems to state the essence of his article, that "Many management (DoD) actions being taken may ultimately compromise the quality of defense hardware." This assumes that prior systems were effective and that a change, or anything less, will reduce hardware quality. Evidence to support this argument is not presented.

Regardless of the controls imposed, quality ultimately and primarily depends on the ability, integrity, and pride of the contractor. This may be difficult to accept, but contemporary history is abundant with examples of the abject failure of combining competence and money to solve complex dynamic problems. We can reflect on the fact that in spite of the billions spent on research and treatment, the longevity of the white male, over 40, has not increased significantly in the last 50 years.

I agree with the author that it would be better to establish attainable goals in place of expected zero defects. The essence of effective quality assurance is the use of human intelligence in decision making based on adequate objective evidence. We often don't have this ideal condition. When we don't, we depend on judgment. This implies occasional error. I do believe that a MIL-Q-9858A or MIL-I-45208 quality system, with realistic acceptable quality levels is an attainable goal and one which can be effectively monitored by the government using surveillance control.

T.J. CARTIN
Dir., Federal Systems Group Quality Assurance
Sanders Associates, Inc.
Nashua, NH

Automated Office System To Get Trial Run

The Rome Air Development Center, Griffiss Air Force Base, New York, has initiated a word- and data-processing program that will allow employees to process information and communicate with each other electronically. When the test program is implemented, selected RADC employees will use video-display terminals, consisting of a typewriter keyboard, linked to a central computer, and a viewing screen to electronically accomplish a wide variety of duties that previously required reams of paper.

The project coordinators are currently identifying the functional needs of the various RADC offices to determine what activities the system will handle. Possible considerations are direct communications, arithmetic calculating, correspondence coordination, file management, personnel programming, and on-line access to data bases. The system will also interface with a nationwide computer network, greatly expanding the data base available to the engineers.

After the functional needs are determined, approximately 15 terminals will be installed at Griffiss and at Hanscom AFB, Massachusetts. Following initial implementation, the next phase will be to automate all of the branches and section offices at RADC. This should require 200 additional terminals.

If the RADC model is successful, the concept will be extended to the other 12 research and development laboratories operating under the Air Force Systems Command's directorate of laboratories.

Navy Aircraft Get Night Vision Devices

The Navy has received the first models of the A-7E Corsair II aircraft retrofitted with a Forward-Looking Infrared Receiver, a new sensor system that enables the pilot to see ships, land vehicles, installations, geographical features and other objects at night and in total darkness. A display unit reveals images of objects and potential targets which are more revealing than those presented by a conventional radar system.

A forward-looking infrared heat-measuring sensor is housed in a pod carried on one of the aircraft's six wing pylons. These pods can be rotated between aircraft by simply attaching the pod to the selected aircraft's pylon. The sensor is linked to the A-7E precision-navigation and weapons-delivery system and provides a magnified view projected on the pilot's display unit in the cockpit. The system has provisions for a video recorder which can play back the infrared imagery attained during a flight. Following a mission, intelligence officers can study this imagery.

The system permits the pilot to detect and identify ships at a sufficient distance at sea for a first-pass attack. The system is capable of portraying in magnified form details not visible to the pilot's naked eye, such as the fuel levels in field-storage tanks. Since 1972, more than 250 test flights of preproduction models have proven the performance, accuracy and effectiveness of the system. Plans call for 340 infrared receivers to be installed on A-7Es during the next five years.

Outstanding Army ROTC Graduate

Second Lieutenant William H. Ibbotson, a graduate from Texas A&M University, has won the Hughes Trophy Award as the outstanding Army ROTC graduate of 1977. He was selected from more than 5,000 Army ROTC graduates for his outstanding leadership and scholastic achievements. A recipient of numerous honors and awards, Lt. Ibbotson, a Distinguished Military Graduate, had previously earned a three-year ROTC scholarship and a two-year Army graduate fellowship. He was selected for membership in several scholastic honorary societies, graduated magna cum laude, and was listed in the 1977 edition of

Who's Who Among Students in American Colleges and Universities. Lt. Ibbotson is currently serving in the 6th Battalion, 14th Field Artillery in Germany. This is the 14th year the award has been presented.

Army Undertakes Water Clean Up

The Army has instituted a pilot project to contain and remove various toxic materials from contaminated ground water at the Rocky Mountain Arsenal near Denver, Colorado.

The granular, activated-carbon purifying system consists of a 1,500-foot-long underground water barrier placed along a portion of the arsenal's north boundary. The barrier blocks the flow of natural ground water from the arsenal into a shallow water table. To avoid cutting off the water source for individual shallow wells for family homes north of the arsenal, the Army is taking the water from six upstream wells, purifying it, and returning the clean water to the table on the other side of the barrier.

A number of studies have revealed that granular activated carbon is the safest and most effective substance for purifying industrial waste water. After ground water is pumped from dewatering wells on the outside of the barrier into a common sump, the water is filtered through the carbon purifying system. The system is capable of removing 99 percent of the pollutants from the water at a rate of 10,000 gallons an hour, 24 hours a day, 330 days a year. Because it is modularly designed, the system can be easily adapted to handle higher flow rates and more stringent water-quality requirements.

The pilot project is expected to provide the data needed to develop a permanent solution to the problem of contaminated ground water at the Rocky Mountain Arsenal.

Air Force Modernizes KC-135 Stratotanker

Aeronautical Systems Division at Wright-Patterson AFB, Ohio, has consolidated management efforts to update the Boeing KC-135 stratotanker aircraft, introduced 21 years ago as the Air Force's first jet tanker. The modernization effort will be handled by the newly created Tanker Modernization Division.

The new division will install new engines, design and install winglets, improve air refueling, and update the avionics systems of the KC-135. Planned modifications to the aircraft are designed to allow it to carry more transferrable fuel, incur lower operational and support costs, emit less exhaust, and use shorter runways for takeoff and landing.

The new division will study the feasibility of updating the stratotanker's avionics system, and it will manage the tanker's foreign military sales program.

Navy Women Pull Sea Duty

The Navy has broken a 202-year-old tradition by announcing that women will be assigned to sea duty.

Fifteen women were recently placed aboard five support vessels, and plans call for a total of 55 women officers and 375 enlisted women to serve on 21 ships by the end of the fiscal year.

Recent legislation, a court decision removing the legal barriers to such assignments, and the projected shortage of male recruits in the 1980s led to the move.

The Navy plans to have 210 women officers and 5,120 enlisted women aboard 55 ships by 1984. Its goal is to have women comprise 25 percent of the crew of each of the 55 ships.

The Navy now has about 24,200 women, 20,000 of whom are enlisted personnel. Women represent 4.3 percent of enlisted personnel and 6.4 percent of officer personnel. By 1983, the Navy plans to double the percentage of enlisted women and increase the percentage of women officers to nearly 8 percent.

Stanley Resor, Under Secretary of Defense for Policy

Resor Is New Top Aide For Policy

Stanley R. Resor, who served as Secretary of the Army from 1965 to 1971, has assumed the newly created position of Under Secretary of Defense for Policy.

Mr. Resor will report directly to the Secretary of Defense on matters pertaining to political-military affairs, arms limitation talks, and the integration of department plans and policies with national security objectives.

Prior to assuming his new position, Mr. Resor was the American representative to the Mutual Balanced Force Reduction Talks in Vienna, Austria.

Navy Announces Energy Award Winners

The Navy announced the 1978 winners of its new Energy Awareness Program for significant savings in energy consumption. Each of the seven winners competed against commands or activities of similar size and had to document energy-saving initiatives, providing exact figures that were compared to a predetermined 1973 base. Winners were:

- The Pearl Harbor Naval Shipyard for reducing energy use by 15 percent.
- The aircraft carrier John F. Kennedy, homeported in Norfolk, Virginia, for saving $6.3 million by following ocean currents which increased the wind speed across the deck during aircraft launching and recovery.
- The frigate BLAKELY, homeported in Charleston, South Carolina, for its automatic boiler control system.
- The Air Test and Evaluation Squadron One (VX-1), Patuxent River, Maryland, for saving $85,000 in aviation fuel in fiscal year 1978.
- The Naval Security Group Activity in Winter Harbor, Maine, for achieving a steady decline in energy consumption over the past five years while maintaining peak readiness.
- The Marine Corps Air Station, Iwakuni, Japan, for greatly reducing its energy use without adversely impacting mission accomplishment.
- The Pacific Missile Test Center, Point Mugu, California, for achieving a fiscal year 1975 energy consumption level that was 27.5 percent less than its 1973 level.

Missile Launcher Passes Trench Test

An experimental transporter/launcher for the U.S. Air Force's proposed Missile X intercontinental ballistic missile system has successfully passed an operational test at Luke Air Force Range, Arizona.

The 127-foot-long breakout-and-erection simulator was constructed by Boeing Aerospace Company as part of a contract to study the feasibility of concealing the advanced MX missiles in covered trenches and moving them about to make targeting by an attacker more difficult. The system is designed to permit a missile to survive an attack, break out of a trench, elevate itself, and be ready to receive a launching command.

During the test, a simulated canister and missile broke through a specially built concrete trench and its ground cover and rose to the launching angle appropriate for intercontinental flight.

The canister was erected by three 66-foot telescoping arms extended by hot gases generated by igniting solid pro-

pellant. Filled with water to simulate the weight of a missile, the 10-foot-diameter canister weighed approximately 386,000 pounds.

The Air Force Space and Missile Systems Organization is studying the covered trench and other concepts to determine the best method of basing MX missiles.

Roland System Being Put Through the Paces

The US Roland Air Defense Missile system, the first foreign-designed major weapon system built in the United States for the Army has successfully passed the principal part of its test program. The program included a series of stringent test firings over the White Sands Missile Range, New Mexico, and ground tests at Aberdeen Proving Ground, Maryland.

In the White Sands test, the missiles were fired against computer-simulated targets, drones, and unmanned F-86 and F-102 fighters. Both U.S. and European missiles were fired interchangeably from fire units manufactured both here and abroad.

At Aberdeen, the system was moved by helicopter to check its transportability and its surveillance radar endured a jolting track test. The all-weather Roland system is manufactured under license from designs developed by French and West German companies. More than 90 percent of the field-replaceable parts and all missiles are interchangeable among the American, French and German fire units (See "U.S. Roland: A Milestone in Technology Transfer," May 1978 *DMJ*). The Army expects to save roughly $600 million and four to five years in development time by using European technology.

Top Navy Job For Equal Opportunity

Mr. Alexander A. Silva is the Navy's first Deputy Assistant Secretary for Equal Opportunity. He will be responsible for developing and implementing equal opportunity policies and programs for Navy military and civilian personnel. In the past, this responsibility was divided between the Assistant Deputy Chief of Naval Operations for Human Resources Management and the Office of Civilian Personnel. The new position was created to underline the Navy's strong commitment to equal opportunity.

Prior to assuming this position, Mr. Silva had been with the General Accounting Office for the past seven years, the last three as its Director of Equal Employment Opportunity. He had served in the Navy from 1947 to 1956 and achieved the rank of first class petty officer.

New Windshield Not Strictly for the Birds

A new, lightweight, birdproof windshield developed for the Air Force's F-111 aircraft will save taxpayers over $100 million by eliminating a scheduled program for structural changes on that plane.

Low-level, terrain-following missions flown by the F-111 expose the aircraft and its crew to greater risk of bird collisions. Many lives have been lost and millions of dollars wasted as a result of such accidents.

The redesigned cockpit enclosure ordered by the Department of the Air Force was developed through the cooperative efforts of the Air Force Flight Dynamics Laboratory, the University of Dayton, and Sierracin Corporation. Capable of withstanding the impact of a 4-pound bird at 500 knots, the enclosure costs less than previous ones, reduces the weight of the crew-escape module by 53 pounds, and is free of the optical problems found in other designs.

The windshield includes a thinner, simpler cross section that has a more balanced center-to-edge performance and employs less optically sensitive processing. By utilizing the same design philosophies and materials technology, technicians can birdproof any aircraft without undertaking costly structural changes.

Deputy Secretary of Defense Charles W. Duncan, Jr., welcomes executives of the minority business community.

DoD Minority Business Program Reaffirmed

Deputy Secretary of Defense Charles W. Duncan, Jr., is holding a series of meetings with executives from the minority business community in order to establish a forum for the exchange of information on the DoD Minority Business Enterprise Program (see "Minority Businesses Taking Wing Under Air Force," January 1978 *DMJ*).

Secretary Duncan declared that DoD's commitment to the program has not been altered by the recent Supreme Court decision in the Allan Bakke case. While acknowledging that the impact of the decision is carefully being analyzed to assure DoD compliance with the Court's ruling, the Secretary reaffirmed DoD's commitment to strengthening its minority business program. He stated that DoD uses goals and target figures merely as guides in achieving results and, as such, is not affected by the Bakke principle.

$25,000 Incentive Award To 12 DoD Employees

Twelve Army scientists from the U.S. Army Armament Research and Development Command's Benet Weapons Laboratory, Watervliet Arsenal, New York, are sharing a $25,000 cash award, the largest attainable under the Federal Employees Incentive Awards Program. The twelve-member team developed a simulated test-firing method for determining the safe firing life of cannon barrels.

The innovative method substitutes laboratory simulation for a major portion of costly firing to determine how long cannon barrels can be used before metal fatigue makes them unsafe. The technique uses an ultrasonic control system that automatically detects the location and depth of cracks that may develop in a gun tube.

Navy Manager Wins Engineering Award

Raye J. Parrott, a Navy computer systems analyst, recently received the 1978 Manufacturing Achievement Award from the Society of Manufacturing Engineers, becoming the first woman professional engineer to be so honored. Ms. Parrott, director of Manufacturing Technology Programs for the Navy's Computer-Aided Ship Design and Construction Program at the Naval Ship Engineering Center in Washington, DC, was cited for her outstanding contributions to computer-aided design and manufacturing of shipbuilding systems.

Event	Date	Place	Contact
Systems Acquisition Management: 1979	Nov. 29-Dec. 1	San Francisco, CA	AIIE Seminars P.O. Box 3727 Santa Monica, CA 90403 (213) 450-0500
Quality Audit—Development and Administration	Dec. 4-6	Milwaukee, WI	American Society for Quality Control 161 West Wisconsin Avenue Milwaukee, WI 53203 (414) 272-8575
Quality Engineering	Feb. 5-9, 1979	Clearwater Beach, FL	
Security Management	Dec. 4-7	St. Louis, MO	Indiana University Center for Public Safety Training ISTA Building, Suite 400 160 West Market St. Indianapolis, IN 46204 (314) 264-8085
Writing Professional and Technical Communication	Dec. 4-7	Washington, DC	George Washington University Continuing Engineering Education Washington, DC 20052 (202) 676-6106
Standards and Specifications for Industry and Government	Jan. 31-Feb. 2, 1979	Washington, DC	
Computer Security Conference	Dec. 6-8	Washington, DC	American Society for Industrial Security 2000 K St., N.W., Suite 651 Washington, DC 20006 (202) 331-7887
Physical Security Conference	Jan. 22-23, 1979	Washington, DC	
Contract Administration and Management	Dec. 11-14	Washington, DC	American Graduate University and Procurement Associates, Inc. 733 North Dodsworth Ave. Covina, CA 91724 (213) 331-5484 or (213) 966-6814
Project Management	Dec. 11-15 Jan. 8-12, 1979	San Francisco, CA Washington, DC	
ADP Procurement	Jan. 15-17, 1979	Washington, DC	Graduate School, USDA 356 National Press Building 529 14th St., N.W. Washington, DC 20045 (202) 447-6693
Conference on Strategic Directions and Defense Technology '79 exposition	Feb. 18-21, 1979	Chicago, IL	Defense Technology '79 411 West Putnam Avenue Greenwich, CT 06830 (203) 323-2179

COMMUNICATIONS, COMMAND AND CONTROL (see p. 4)